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STATEMENT OF AUTHORSHIP

I hereby certify that the following thesis is my own work. Any material borrowed from another author or piece of work has been given due acknowledgment in the thesis. This thesis, in whole or part, has not been submitted for the award of any degree in any other tertiary institution.

Signed Leanne Foley Leanne Foley

Date 25/6/97

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ABSTRACT

The claim has been made that spaced retrieval has efficacy as a mnemonic technique in individuals with dementia. Spaced retrieval involves active attempts to retrieve the to-be-remembered information over expanding intervals of time. It has also been suggested that cognitive effort may be a plausible theoretical explanation for the efficacy of the technique in this population. The present study reports an experiment that investigated the efficacy of spaced retrieval as a mnemonic for people with dementia, the active factors in this technique, and the role of cognitive effort in assisting acquisition through spaced retrieval. In the present experiment, subjects diagnosed as either suffering from Alzheimer's Disease or Vascular Dementia were required to learn face-name associations using four different encoding techniques: spaced retrieval, spaced reminding, massed retrieval and massed reminding. Memory performance was measured by cues required for successful recall following delay. The results showed that spaced retrieval was superior to the other three conditions in assisting acquisition and subsequent delayed recall. Theoretically, it appears that both the active attempts at retrieval and the spacing schedule that these retrieval trials are conducted on are necessary active factors in the technique. Furthermore, response time data taken during spaced retrieval suggest that cognitive effort is a plausible theoretical explanation for the efficacy of the technique. Propositions regarding the fate of the memory trace during spaced retrieval are discussed, and arguments against claims that spaced retrieval is automatic and non-effortful in those with dementia are raised.

1.0 DEMENTIA

Dementia is proving a serious problem due to its increase in prevalence as a result of an aging population, its irreversible and progressive nature, the cost of care for sufferers and the strain it places both on care givers and the patients themselves. In 1993, between 100,000 and 140,000 Australians suffered from moderate to severe dementia and this number is expected to exceed 200,000 within ten years (Senate Report, September 1994).

Figures from 1987 indicate the prevalence of dementia in Australia to be 0.72% in the 60-64 age group, rising to 38.63% in the 90-95 age group (Jorm, Korten & Henderson, 1987). An estimate calculated in the 1980s suggested that the incidence of Alzheimer's Disease and vascular dementia among those over 65 was between 1.4 and 2.7% (Kaszniak, 1986). One in eight adults are likely to develop some form of dementia, and Alzheimer's Disease is the fourth largest killer of adult Australians (Senate Report, September 1994).

The average lifespan of an individual with dementia is generally seven years from diagnosis (Strub & Black, 1988 as cited in Berg, Franzen & Wedding, 1994): they have approximately 1/3 the life expectancy of non-demented age matched controls (Go, Todorov, Elston & Constantinidis, 1978). At present, despite pharmacological research (see Ferris 1990 for a review), there is no treatment that is effective in preventing or stopping the progression of the disease (St George-Hyslop et al. 1987; Kaszniak, 1986).

1.1 What is Dementia?

In a very broad sense, dementia can be defined as "the global impairment of higher cortical functions including memory, the capacity to solve problems of day-to-day living, the performance of learned perceptuomotor skills, the correct use of social skills and control of emotional reactions, in the absence of gross clouding of consciousness". (Anonymous, 1981). The term dementia refers to a clinical syndrome produced by many different disorders and characterised by a loss of brain functioning as a result of diffuse organic brain disease (Berg et al. 1994; Reid, 1994).

Pathological studies have revealed that 80% of all irreversible dementia in old age is of two major types, namely primary degenerative dementia of the Alzheimer type and vascular dementia (Hart & Semple, 1990). The ratio of Alzheimer's Disease to vascular dementia is approximately 3:1 (Kasznik, 1986), although it does vary between different age groups (Amaducci, Falcini, & Lippi, 1992). Females have almost a threefold higher prevalence rate for Alzheimer's Disease than males in each age category (Berg et al. 1994). In contrast, males have a slightly higher prevalence of vascular dementia (Berg et al. 1994). These two conditions are very difficult to distinguish clinically, generally requiring autopsy to do so, and are often found coexisting in an individual with dementia (Hart & Semple, 1990). For the purposes of this thesis, discussion will be limited to vascular dementia and Alzheimer's Disease.

1.2 Pathology of Alzheimer's Disease

Alzheimer's Disease was first described by Alois Alzheimer in 1907 (Smith, 1989). At present the exact aetiology of Alzheimer's Disease remains unknown (Hart & Semple, 1990). The available data seem to suggest that the disease is not likely to be the result of a single genetic abnormality, but rather is likely to be a combination of both genetic (Amaducci et al. 1992; St George-Hyslop et al. 1987) and non-genetic factors (Amaducci et al. 1992; Berg et al. 1994; Smith, 1989; St George-Hyslop et al. 1990). Some have posited that Alzheimer's Disease may merely be an acceleration of normal aging (Khachaturian, 1985), although this remains inconclusive.

Although the exact aetiology of the disease remains largely unknown, pathology has provided insight into the discernible brain changes that accompany the disease. At a gross macroscopic level, Alzheimer's Disease is characterised by widespread cortical atrophy and ventricular enlargement (Hart & Semple, 1990). There is a loss of cortical neurones particularly in the frontal and temporal lobes and in the hippocampus (Kaszniak, 1986), and a restriction of dendritic branching in those neurones that remain (Terry & Katzman, 1983). The degree of neuronal loss and atrophy correlates positively with the severity of the accompanying dementia (Alatuzoff, 1992).

Several distinctive changes in brain morphology accompany Alzheimer's Disease and these remain the diagnostic markers for a clinical diagnosis. The two major neuropathological hallmarks are neurofibrillary tangles and senile plaques (Ulrich, 1990). Neurofibrillary tangles are found prominently in the hippocampal and subicular areas of the brain, but are also found widely throughout the cortex (Hart & Semple, 1990). Senile plaques are found widely distributed throughout the cortex (Tomlinson et al. 1970, as cited in Hart & Semple, 1990), with the frontal and temporal lobes most susceptible (Kaszniak, 1986). A robust correlation exists

between the quantity and density of these tangles and plaques, and the severity of the dementia and resulting cognitive deficits (Coyle, Price & DeLong, 1983; Wilcock & Esiri 1982, as cited in Hart & Semple, 1990). The number of plaques and tangles increase with the progression of the disease (Alatuzoff, 1992). Additionally, granulovacuolar degeneration and Hirano bodies are found in the Alzheimer brain, predominantly in the hippocampal area (Hart & Semple, 1990).

Cholinergic dysfunction is now also known to be an important and consistent feature of Alzheimer's Disease (Christensen, Maltby, Jorm, Creasey & Broe, 1992; Coyle et al. 1983; Hart & Semple, 1990; Kopelman, 1986c; Kopelman, 1992; Nordberg, 1992; Whitehouse, Price, Struble, Clark, Coyle & DeLong, 1982). Positive correlations have been found between the amount of disruption to the cholinergic system and the level of cognitive impairment (Nordberg, 1992). Post-mortem neurochemical analyses suggest that Alzheimer's Disease may actually be a multi-transmitter disease (Nordberg, 1992), with abnormalities in noradrenaline, serotonin, GABA and/or somatostatin having also been found in the brains of Alzheimer's patients (Kopelman, 1986c; Mann & Yates 1986, as cited in Hart & Semple, 1990; Smith, 1989).

1.3 Pathology of Vascular Dementia

An accumulation of occlusions of blood vessels, which are secondary to a disease of the heart or extracranial blood vessels and result in focal infarcts throughout the brain, are the most likely cause of vascular dementia (Alatuzoff, 1992; Hart & Semple, 1990). Vascular dementia refers to cases of dementia resulting from ischaemic and haemorrhagic brain lesions, in addition to cerebral ischaemic-hypoxic lesions such as those due to a cardiac arrest (Roman et al. 1993). This form of dementia is almost always accompanied by a history of hypertension (Berg et al. 1994).

The focal lesions characteristic of vascular dementia are found in both white and grey matter structures, including subcortical areas (Alatuzoff, 1992; American Psychiatric Association, 1994; Hart & Semple, 1990). The vessel most often implicated in vascular dementia is the cerebral artery, with the posterior and anterior arteries also involved (Hart & Semple, 1990). The major sites of such vessel occlusion are the temporal and parietal lobes, the thalamus, the basal ganglia and parts of the limbic system including the hypothalamus (Hart & Semple, 1990).

Despite vascular dementia historically being equated with cerebral infarct, recent research has indicated that vascular dementia can exist in the absence of actual cerebral infarct (Emery, Gillie & Ramdev, 1996; Emery, Gillie & Smith, 1996). An argument has subsequently been made for the existence of various subtypes of vascular dementia (multi-infarct, single infarct & non-infarct).

Although these subtypes have been differentiated pathologically, mental status and neuropsychological measures have failed to differentiate these groups on the basis of cognitive functioning (Emery et al. 1996). As the focus of the current thesis is on cognitive functioning in dementia, these subtypes will be considered together under the generic term "vascular dementia".

The presenting neurological and neuropsychological deficits seen in vascular dementia are determined first by the particular brain areas damaged as a result of being supplied by the occluded vessels (Cummings & Benson 1983, as cited in Hart & Semple, 1990), and second by the amount of accumulated damage (Alatuzoff, 1992). Many of the clinical features of vascular dementia reflect subcortical dysfunction, in addition to the cortical dysfunction that is more common in Alzheimer's Disease (Roman et al. 1993). The damage in vascular dementia can present as sketchy and focal. However, when an individual is clearly suffering from vascular dementia, the damage is likely to be multi-focal and diffuse.

1.4 Neuropsychological Profile of the Dementia Patient

Due to the correspondence in sites of injury between vascular dementia and Alzheimer's Disease, the presenting cognitive impairments are similar. Not surprisingly, given the principal locations of brain injury, the central neuropsychological deficits observed are in the domains of memory, language and visuospatial processing ability (Reid, 1994).

In the early stages of the disorder, often referred to as the forgetfulness phase (Schneck, Reisberg, & Ferris, 1982), the person may experience difficulties with episodic memory and encounter problems in their ability to perform day to day tasks (Kopelman, 1986b). They may also suffer from depression and irritability, and become confused in response to change (Berg et al. 1994). Subtle problems with drawing, copying, naming and word finding may be present (Kopelman, 1986b; Reid, 1994). Basic sensory and motor functions appear to remain relatively intact (Zec, 1993). At this stage, it may be difficult to distinguish the individuals problems from those of normal aging (Kaszniak, 1986).

As the disease progresses, memory difficulties become more pronounced (Berg et al. 1994) and problems in visuospatial functioning such as spatial disorientation emerge (American Psychiatric Association, 1994; Ferris, 1992). Obvious difficulties in both the reception and expression of language appear and deteriorate over time (Appell, Kertesz & Fisman, 1982). Often there are problems in initiating speech and the speech that is generated is vague and impoverished (Appel et al. 1982; Hart & Semple, 1990). The ability to name and find abstract words is compromised and difficulty in the ability to name objects emerges over time (Appell et al. 1982; Reid, 1994). Reading skills typically remain intact until the disease is quite advanced (Nelson & McKenna, 1975). Receptively, the individual is usually able to understand

and respond initially if the speech directed at them is simple, but difficulties arise in the comprehension of abstract concepts (Appell et al. 1982).

Problems in concentration, attention and executive functioning also accompany the progression of the disease (American Psychiatric Association, 1994; Baddeley, Logie, Bressi, Della Sala & Spinnler, 1986; Berg et al. 1994; Black & Strub, 1994; Ferris, 1992; Hart & Semple, 1990; Kaszniak, 1986; Kopelman, 1986b; Kopelman., 1992; Reid, 1994; Walsh, 1978). Attention difficulties may present as a sluggishness in response, a lack of vigilance, inertia, an inability to divide attention and difficulty switching trains of thought (Baddeley et al. 1986; Reid, 1994). Disorders in executive functioning commonly present as problems in the ability to think abstractly, to be mentally flexible, to be verbally fluent, and/or to plan, sequence, initiate, execute, monitor and cease behaviour or action programs that are not habitual or well learned (American Psychiatric Association, 1994; Butters, Granholm, Salmon, Grant & Wolfe, 1987; Ferris, 1992; Kopelman 1991b; Lezak, 1976; Reid, 1994; Walsh, 1978).

Changes in mood, personality and behaviour also become salient (Berg et al. 1994; Ferris, 1992; Kaszniak, 1986; Walsh, 1978). It is these changes that are often most distressing to families and are the most difficult to treat (Rabins, Mace & Lucas, 1982). The person may begin to wander aimlessly, become anxious, display motor restlessness, become agitated and/or violent, display unanimated or labile moods, suffer sleep disturbances and in some cases exhibit psychiatric symptoms (American Psychiatric Association, 1994; Berg et al. 1994; Edwards, 1994; Ferris, 1992; Kaszniak, 1986). Often their behaviour becomes disinhibited (American Psychiatric Association, 1994). Social judgment may be impaired and they may act towards strangers as if they are familiar, may neglect personal hygiene, tell inappropriate jokes, and show a lack of concern for others (American Psychiatric Association, 1994; Berg et al. 1994; Kaszniak, 1986; Walsh, 1978). They may also become

particularly vulnerable to physical or psychosocial stressors (American Psychiatric Association, 1994).

As the disease progresses, the comprehension of both spoken and written language may become jeopardised (American Psychiatric Association, 1994). The ability to use language as a tool for communication gradually breaks down (Appell et al. 1982). Infantile reflexes such as a grasp or rooting reflex may emerge (Berg et al. 1994). In the terminal stages of the disease the person becomes mute, incontinent and wasted (Kopelman, 1986b). All motor, sensory and mental abilities will be impaired and personality disturbances will be conspicuous (Berg et al. 1994). Additional problems may include dysphasia, aphasia, agnosia, increased muscle tone, disturbances of posture and gait, paranoia, enuresis and seizures (Hart & Semple, 1990; Reid, 1994).

The profile just presented lists the multitude of problems that may be observed in people with dementia. It must be noted however that not all patients will display all symptoms, and that both between and within Alzheimer's Disease and vascular dementia there appears to be a heterogeneity in the patterns of cognitive deficits seen (Kasznick, 1986).

1.5 Diagnosing Dementia and Distinguishing Vascular Dementia from Alzheimer's Disease

A diagnosis of dementia is made if an individual in middle to late life exhibits a permanent and irreversible decline from prior levels of functioning in cognitive domains, especially in the area of memory. Such decline must be evidenced behaviourally both in day to day performance, and in clinical examination and neuropsychological tests (McKhann, Drachman, Folstein, Katzman, Price & Stadlan, 1984).

A diagnosis of dementia is ruled out if the person is suffering from delirium or coma, or if other difficulties prevent an adequate evaluation of their mental functioning (McKhann et al. 1984). Other causes that could account for the cognitive deficits such as Huntingdon's Disease, Parkinson's Disease, drug dependency and thyroid disease (McKhann et al. 1984; Reid 1994) must also be eliminated. Depression may often masquerade as a dementia (pseudo-dementia), and is a frequent accompaniment to dementia (Feinberg & Goodman, 1984), thus it too must be excluded as a potential cause of cognitive symptoms.

The fact that both Alzheimer's Disease and vascular dementia are characterised by diffuse organic brain disease and result in a loss of brain functioning (Berg et al. 1994; Reid, 1994) means that their clinical presentation will be very similar. Comorbidity of the two disorders is also high with around 19% of dementia cases suffering Alzheimer's Disease and vascular dementia concurrently (Jorm & Henderson, 1993).

In general, the ability of techniques such as CT scans or EEG to accurately distinguish Alzheimer's type dementia or vascular dementia from normal aging is doubtful (Fox, Kaszniak & Huckman, 1979). Positron emission tomography (PET), cerebral blood flow (CBF) and magnetic resonance imaging (MRI) do hold some potential but such equipment is not readily available (Friedland, Budinger, Brant-Zadowski & Jagust, 1984; Kaszniak, 1986). The diagnosis of vascular dementia can sometimes be made on the basis of brain imaging techniques if the infarcts are large. However if the dementia is a result of multiple small infarcts or a combination of vascular dementia and Alzheimer's Disease, accurate diagnosis can only be made at autopsy.

Some clinical characteristics have been proposed to assist the distinction between Alzheimer's Disease and vascular dementia. While Alzheimer's Disease is

characterised by a gradual onset and progressive decline in cognitive functioning, vascular dementia has an abrupt onset, a stepwise pattern of deterioration, nocturnal confusion, focal neurological signs and symptoms, a fluctuating course, relative preservation of personality, somatic complaints such as palpitations and headache, and emotional lability (Berg et al. 1994; Hart & Semple, 1990; Reid, 1994; Walsh, 1978). Additionally, the neurological signs of vascular dementia are likely to be more dramatic than those seen in Alzheimer's Disease (Berg et al. 1994).

Unfortunately, such characteristics are difficult to assess accurately and their use in distinguishing the two disorders has been questioned (Fischer, Gatterer, Marterer, Simanyi, Danielczyk & Course, 1991). Neuropsychological test profiles may present some differences, however they do not provide a reliable differentiation (Hart & Semple, 1990).

In recognition of the difficulties with diagnosing Alzheimer's Disease a work group on the diagnosis of the disorder was established by the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) and the Alzheimer's Disease and Related Disorders Association (ADRDA) (McKhann et al. 1984). The group have developed a set of criteria to serve as a clinical basis for the diagnosis of Alzheimer's Disease. These criteria have since been shown to have validity and reliability (Kukull, Larson, Reifler, Lampe, Yerby & Hughes, 1990a; Kukull, Larson, Reifler, Lampe, Yerby & Hughes, 1990b) and will be used as the principle means of diagnosis here.

In order to satisfy a diagnosis of Probable Alzheimer's Disease, an individual must display impairment on a cognitive screening test, they must evidence neuropsychological impairment in two or more cognitive areas (at least one of which must be memory) as defined by a performance in the lower 5th %ile of a matched control group, onset of the symptoms must begin after age 40, there must be

evidence of temporal decline, and the individual must meet the inclusion and exclusion criteria outlined above (McKhann et al. 1984). This diagnosis of probable Alzheimer's Disease is supported by evidence of specific problems such as aphasia, apraxia or agnosia, problems with activities of daily living, a family history of similar disorders, and physiological/neurological laboratory evidence (McKhann et al. 1984).

A diagnosis of Possible Alzheimer's Disease can be given if there is evidence of dementia in the presence of another disorder which could produce dementia but is not believed to do so in this case, or if there is evidence of a severe progressive decline in only one cognitive domain (McKhann et al. 1984). Full NINCDS-ADRDA criteria can be found in Appendix I (Table 1) and will be used in the current study.

A similar set of standard diagnostic criteria for vascular dementia have been developed by NINCDS, in conjunction with the Association Internationale pour la Recherche et l'Enseignement en Neurosciences (AIREN) (Roman et al. 1993). In the absence of accessibility to the brain imaging techniques which form part of the NINCDS-AIREN criteria, however, the Psychogeriatric Assessment Scale (PAS; Jorm & MacKinnon, 1994) was used for the research reported here to distinguish vascular dementia from Alzheimer's Disease. This scale aims to assess psychogeriatric disorders along a continuum and possesses both reliability and validity (Jorm et al. in press).

The PAS consists of a subject interview and an informant interview. From the former, scales of stroke, depression and cognitive impairment are derived. The latter interview provides scales of stroke, cognitive decline and behaviour change. The composition of these scales is shown in Appendix I (Table 2). Once scores on all six scales have been calculated, these can be converted to percentiles in order to allow direct comparison with a standard population, and a profile can be constructed. Each subject's profile can then be compared to average profiles for cases of Alzheimer's

Disease and vascular dementia presented in the manual in order to determine which diagnosis is more consistent.

In the present study, the PAS will be used in addition to the NINCDS-ADRDA criteria to diagnose patients. However as level of cognitive functioning is more important than diagnosis per se and the cognitive deficits in the two disorders are similar, they will be considered together under the generic term "dementia".

1.6 Outline of the Memory Deficits in Dementia

As previously discussed, one of the most obvious cognitive functions to decline with the progression of dementia is memory (Morris & Kopelman, 1986). This decline is gradual, pronounced, diffuse and is a universal characteristic of the disease (Zec, 1993). Often difficulties with memory are evident early in the course of the disorder and precede other more focal neurological symptoms (Hart & Semple, 1990). Such a comprehensive memory deficit is likely to result from cholinergic dysfunction and the extensive damage to the temporal lobe and hippocampus already described.

Initially, remembering recently occurring events may be difficult and as the disease progresses, memory for remote events may become impaired (Hart & Semple, 1990; Morris & Kopelman, 1986; Wilson, Kaszniak & Fox, 1981). These impairments encompass both semantic and episodic memory (Grafman, Weingartner, Lawlor, Mellow, Thompsen-Putram & Sunderland, 1990; Hodges, Salmon & Butters, 1992; Kaszniak, 1986; Kopelman, 1992; Mitchell, Hunt & Schmitt, 1986; Morris & Kopelman, 1986; Zec, 1993), cover both the verbal and non-verbal domains (Kaszniak, 1986; Kopelman, 1991b; Kopelman, 1992), and have been observed in both effortful and automatic memory (Grafman et al. 1990; Weingartner et al. 1982). Such deficits manifest themselves in tests of list learning, paired associate learning, story learning, and face and picture learning, when measured through either

recognition and recall (Huppert 1988, as cited in Reid, 1994; Kaszniak, 1986; Miller, 1975; see Morris & Kopelman, 1986 for a review). Other memory abnormalities seen in dementia include a failure to display proactive interference (Kaszniak, 1986), a steep recency effect in memory span and lack of a primacy effect (Dick, Kean & Sands, 1989).

The fate of procedural learning in dementia is still debated (Kopelman, 1992), with some claiming that, at least initially, it remains relatively intact (Nissen, Knopman & Schacter 1987, as cited in Grafman et al. 1990; Zec, 1993). A similar contention exists regarding implicit memory functioning in dementia with several studies citing evidence of impairment (Shimamura, Salmon, Squire & Butters, 1987), others finding relative preservation (Graf & Mandler, 1984; Morris, Wheatley & Britton, 1983; Moscovitch 1982, as cited in Morris & Kopelman, 1986; Perfect, Downes, De Mornay Davies & Wilson, 1992), while others still have found variations in functioning depending on the specific implicit memory task administered (Bondi & Kaszniak, 1991; Butters, Heindel & Salmon, 1990; Downes, Davis, De Mornay Davies, Perfect, Wilson, Mayes & Sagar, 1996; Heindel, Salmon, Shults, Walicke & Butters, 1989; Margolin, Pate & Friedrich, 1996; Russo & Spinnler, 1994).

Some researchers have proposed that the memory loss in Alzheimer's Disease consists of a focal amnesic syndrome accompanied by a dysexecutive syndrome (Becker, Bajulaiye & Smith, 1992; Morris & Kopelman, 1986). The amnesic syndrome is responsible for such characteristics as deficits in learning and long-term memory while the dysexecutive syndrome is identified by difficulties in problem solving, cognitive resource allocation, rapid information processing, short-term memory and shifting and maintaining central sets (Becker et al. 1992). While attractive, this model of the memory deficit in Alzheimer's disease is only a proposed model and may not hold fast with more rigorous research (Becker et al. 1992).

1.7 Deficits in Acquisition, Retention and Retrieval

In order to determine at what stage in memory the deficits occur, the standard division of memory into the three stages of acquisition, retention and retrieval is commonly adopted (Morris & Kopelman, 1986). Research into the nature of the memory deficits in those with dementia, generally using list-learning paradigms, indicates impairment in both acquisition of information and in later retrieval of that information, although ability to retain information once acquired and consolidated remains relatively spared.

Acquisition: The majority of studies that have attempted to examine acquisition ability in those with dementia have done so by either manipulating information presentation at acquisition, or by manipulating retrieval cue strength, in order to investigate the effect these have on memory for the information.

Several studies have demonstrated that clustering words into semantic categories at acquisition - a manipulation which is known to assist later recall in non-dementing individuals - does not assist memory for the information in those with dementia (Morris & Kopelman, 1986; Weingartner, Kaye, Smallberg, Ebert, Gillin & Sitaram, 1981). The conclusion reached from these studies was that those with dementia must possess a disturbance in their ability to acquire new information. Subsequent questions have been raised regarding the validity of these conclusions as many of the experiments have utilised a recall method known to be impaired in this population, namely free recall (Grafman et al. 1990; Miller, 1975; Morris et al. 1983; Tuokko & Crockett, 1989). Thus, research has confused the ability to acquire the information with an ability to retrieve what has been learned.

However, studies that have used appropriate retrieval strategies for this population have still found deficits in acquisition (Bird & Luszcz, 1991; Diesfeldt, 1984).

Contrary to what is seen in non-dementing individuals, increasing cue potency from a single letter to a semantic category cue at retrieval does not increase the ability of the individual with dementia to recall the information (Davis & Mumford, 1984). Had the information been processed semantically and encoded successfully, cued recall using semantic cues should be superior to cued recall using an initial letter cue. Davis and Mumford (1984) interpreted the failure to find a semantic category cue advantage as evidence that the individual with dementia is unable to adequately encode new information.

Furthermore, Kopelman (1986b) has shown that dementia patients are able to repeat back newly presented logical sentences as well as matched controls, but they are impaired in their ability to repeat back newly presented illogical sentences. Given that both conditions used identical methods of retrieval, the deficit observed for illogical sentences was interpreted as evidence of an impairment in acquiring new information.

Retention: The rationale of studies comparing retention deficits with acquisition deficits is that if the deficit is one of acquisition, performance of dementia patients will be poorer at initial testing than controls, and their performance will remain poorer by this constant amount at each delay interval (Slamecka & McElree, 1983). Conversely, impaired storage in those with dementia would alter the slope of their forgetting curve, with a relatively more rapid decline than controls at each delay (Slamecka & McElree, 1983).

Several studies have shown that there may be a reasonably rapid rate of forgetting immediately after learning in those with dementia (Moss, Albert, Butters & Payne, 1986). However, it has been found that if the material is adequately learned or consolidated and if initial learning levels are equated with their comparison groups, the retention over longer periods of time in those with dementia is comparable to

non-dementing elderly (Kopelman, 1985; Morris & Kopelman, 1986). That is, the slope of their forgetting curves are comparable.

One study conducted in 1992 by Money, Kirk and McNaughton compared Alzheimer's patients with control subjects on a computerised delayed matching to sample task. They found that the Alzheimer's group showed poorer discriminability at zero delay than controls, but equivalent rates of forgetting over a 32 second delay. This finding led the researchers to conclude that Alzheimer's disease may have little effect on mechanisms that underlie maintenance of the memory trace, but instead it may affect encoding, initial storage of information, or retrieval. Similar conclusions were drawn by Kopelman (1991b) after finding comparable rates of decay beyond the first data point between a dementia and control group using a block span task.

Other researchers have conducted memory experiments examining the rate of forgetting in dementia patients, and they have reached similar conclusions regarding the ability of those with dementia to retain new information (Kopelman, 1985; Little, Volans, Hemsley & Levy, 1986).

Retrieval: The retrieval deficit in dementia is very widely recognised. The most striking demonstration of this deficit is that patients are unable to free-recall previously learned information, but they are sometimes able to recall it once appropriate assistance is given at retrieval (Miller, 1975; Morris et al. 1983; Tuokko & Crockett, 1989). In a study conducted by Martin and colleagues in 1985 (Martin, Brouwers, Cox & Fedio, 1985), subjects suffering from Alzheimer's type dementia were required to generate a semantic association to go with a word during encoding. They found that such encoding failed to enhance free recall of words, but that cued recall of such words was increased. Similarly, Morris and colleagues (Morris et al. 1983) found that their "dementia" group were impaired on a five minute delay yes/no

recognition of a list of previously studied words, but their performance was equivalent to a control group on cued recall of a such a list.

Miller (1978) has posited that the retrieval deficit in dementia is due to an inability to inhibit recall of irrelevant information. He found that in a recognition task, his "dementia" group were more likely to erroneously match a word with an incorrect alternative than his "control" group, and the probability of this happening increased with the number of alternatives presented. He termed this the disinhibition hypothesis of the retrieval deficit, and others (Morris et al. 1983) have claimed that the efficacy of cued recall lies in decreasing the possible number of interfering response alternatives, thus enabling a subject to respond correctly.

2.0 ASSISTING MEMORY IN DEMENTIA

The above studies suggest that more information can be registered and stored in the memory of those with dementia than previously thought (Morris et al. 1983). If techniques can be used to increase the chance of information being acquired and the material being consolidated in memory, and/or if sufficient assistance is then given at retrieval, it may be possible to tap this residual ability and patients with dementia will be able to retain information and recall it after certain delays of time (Karlsson, Backman, Herlitz, Nilsson, Winblad & Osterlind, 1989; Miller, 1978; Morris et al. 1983).

2.1 Assistance at Acquisition and/or Retrieval?

The first question to ask when considering how to ensure optimal remembering in dementia patients is whether assistance is necessary at both acquisition and retrieval. A study conducted by Bird and Luszcz (1991) attempted to answer this question. The results of their study revealed that remembering was only enhanced when cued assistance was provided at both ends of the processing continuum. For any effect of manipulations at encoding to become apparent, recall assistance is also required. Similar conclusions have been reached by other researchers (Buschke, 1984; Davis & Mumford, 1984; Tuokko & Crockett, 1989). Evidently any techniques that are utilised to try and ameliorate some of the memory problems of dementia sufferers require assistance to be given at both ends of the processing continuum.

Given the relatively consistent finding that cued recall is an effective method of assisting retrieval in this clinical population (Davis & Mumford, 1984; Morris et al. 1983), attention has turned to ways to assist acquisition.

2.2 The Levels of Processing Framework and Acquisition Assistance

The levels of processing framework for memory proposed by Craik & Lockhart (1972) states that the memory trace that is laid down is a product of the analysis that is carried out on it during learning, and that the strength of the trace is determined by the depth of this analysis. Preliminary analysis is generally done on the basis of the physical or sensory aspects of the stimulus. Later stage analysis typically involves things such as pattern recognition and extraction of meaning. These later stage analyses are considered deeper levels of processing than preliminary analyses and therefore are associated with more elaborate, persistent and stronger memory traces. In simple terms, the levels of processing framework of memory states that the likelihood of remembering information depends on how well the information is

encoded (Tulving, 1983), with lower levels of processing resulting in poor encoding and consequently poor storage and memory for the information (Epstein, Phillips & Johnson, 1975; Eysenck 1977, as cited in Davis & Mumford, 1984).

This levels of processing framework has direct relevance to attempts to assist acquisition in those with memory problems. It follows logically from the framework that in order for any assistance at acquisition to be effective, it would need to aim at ensuring information is processed adequately thus maximising the chance of a discriminable trace being formed (Davis & Mumford, 1984; Jacoby & Craik, 1979).

In a later critique and expansion of the original levels of processing framework (Craik & Lockhart, 1972), Jacoby and Craik (1979) claimed that there are several methods of ensuring adequate processing of information in order to assist memory. Encoding specificity, cue elaboration and cognitive effort are three such methods.

Briefly, encoding specificity refers to the similarity of cues given at acquisition to those given at retrieval (Thomson & Tulving, 1970; Tulving, 1983; Tulving & Thomson, 1973). If an individual is able to associate a stimulus with a contextual cue at acquisition, they may be able to use that contextual cue as a retrieval cue later on and make it easier to locate the to-be-learned information (Bird & Luszcz, 1991, 1993). Additionally, the more pieces of associated information that are encoded with the to-be-remembered information, the more distinct the memory trace, and the more cues available for use at retrieval (Saltz, 1988). Jacoby and Craik (1979) refer to this method of assisting acquisition as cue elaboration. A third way of enhancing the memory trace (Jacoby and Craik, 1979), and one that will be the focus of the present paper, is cognitive effort.

2.3 Cognitive Effort and Memory

The amount of cognitive effort required by a task is an important determinant of later recall performance (Tyler, Hertel, McCallum & Ellis, 1979). It has been found that the more difficult a task is to perform and the more effortful the processing carried out on the to-be-remembered information, the more distinctive the resulting memory trace (Buyer & Dominowski, 1989; Plude, 1992) and consequently the greater the recall (Mitchell & Hunt, 1989; Tyler et al. 1979). This effect has been shown to be independent of both levels of processing and total study time of the to-be-remembered information (Tyler et al. 1979).

Cognitive effort is defined technically as the proportion of available capacity or processing resources allocated to performing a given task (Mitchell & Hunt, 1989; Tyler et al. 1979). Processing is considered effortful if it requires significant capacity and attentional resources, and is initiated intentionally. Effortful processes can be changed by instruction and instituted. Such operations as using imagery, elaboration, mnemonics, retrieval, organisation, clustering and rehearsal during learning are all considered effortful (Hasher & Zacks, 1979).

Some have queried this direct causal relationship between cognitive effort and memory, saying instead that performance on a task will be a function of cognitive effort if, and only if, the task requirements exceed available resources (Mitchell & Hunt, 1989). Known as the "capacity model" of cognitive effort, this suggests that variations in cognitive effort establish a theoretical boundary for memory and will only lead to variations in memory if the individual has insufficient resources to support the processes required by the task (Mitchell & Hunt, 1989).

Given the memory problems experienced by those with dementia, one would expect that a memory task would exceed the individual's capacity and consequently their

recall will be a function of the amount of cognitive effort invested in learning the information. The implication of this for memory intervention is that if manipulations can be made at encoding that will induce deeper or more elaborative processing, and ensure that cognitive effort is put into learning, long-term recall should be facilitated (Craik & Lockhart, 1972).

2.4 Attempts at Assisting Acquisition in Those With Dementia

Non-dementing individuals tend to perform automatically some type of elaborative encoding when presented with information in order to aid their later retrieval of that information (Tulving, 1983). In contrast it seems that dementia sufferers cannot be relied upon to undertake voluntarily cognitive operations at acquisition which will produce a discriminable memory trace (Jorm, 1986; Morris & Kopelman, 1986).

Dementing individuals have deficits in controlled processing (Jorm, 1986). They have difficulty in consciously attending to and processing information (Schneider & Shiffrin, 1977), and do not automatically encode contextual cues when presented with information to remember (Granholt & Butters, 1988). As a consequence, they do not spontaneously utilise such methods as cue elaboration, encoding specificity or cognitive effort in order to ensure material will be remembered. Evidently, where specific information is to be taught to dementia sufferers, external assistance will be required in order to ensure adequate processing of the stimuli (Bird & Luszcz, 1993).

In non-dementing individuals, memory can be assisted by ensuring that instructions, retrieval conditions or materials guide the learner in initiating the appropriate cognitive operations during learning which will ensure a retrievable memory trace is laid down (Backman, 1990). Generally these attempts to increase retention in non-dementing older adults concentrate on methods such as repetition, the use of external

memory aids, and the use of mnemonic strategies including rehearsal and the use of imagery (Dick et al. 1989; Harris, 1992; West, 1989).

While such memory assistance has been shown to be useful in improving memory in the unimpaired elderly, attempts to train those with dementia to use internal mnemonic strategies such as visual or verbal imagery (Backman, Josephsson, Herlitz, Stigsdotter & Viitanen, 1991) or to benefit memorially from the effects of simple repetition (Camp, 1989; Little et al. 1986), have been unsuccessful. This is hardly surprising considering these techniques rely on skills that are impaired in dementia (Camp, Foss, O'Hanlon & Stevens, in press) and also do not provide external assistance to firstly acquire and then retrieve the information.

Additionally attempts to get these individuals spontaneously to use external aids to memory such as signposts, notices and diaries without practical training have been ineffective (Camp & McKittrick, 1992; Hanley, 1981; Hanley, McGuire & Boyd, 1981) as they are either unable to judge when their use is appropriate, they may fail to encode the association between the external aid and the information to be remembered, or they may actually forget to use them (Camp & McKittrick, 1992; Hanley, 1986; Intons-Peterson & Newsome, 1992; Moffat, 1992). It is unrealistic to expect most memory impaired people to be able to spontaneously use any memory strategy (Wilson, 1992a).

3.0 SPACED RETRIEVAL

Given that traditional mnemonic techniques which are successful in the unimpaired are ineffective for use in those with dementia, are there any mnemonic techniques which incorporate some of the above elements identified as essential for aiding acquisition in dementing individuals which may show more success? One such technique is spaced retrieval. This technique is designed to assist acquisition of information and involves active attempts to recall the to-be-remembered information over expanding intervals of time (Stevens, Camp & O'Hanlon, 1992).

There are two main components to the spaced retrieval technique. The first of these is the use of active attempts to retrieve the to-be-remembered information, and the second component is the spacing schedule for these retrieval trials.

3.1 Historical Development of the Spaced Retrieval Technique

It is a well known phenomenon in the learning literature that massed rehearsal of information is a less effective method of acquiring information in terms of later ability to recall it, than is spaced rehearsal of the information (Bjork & Allen, 1970; Cuddy & Jacoby, 1982; Dempster, 1988; Landauer & Bjork, 1978; Payne & Wenger, 1992; Perruchet, 1989; Rea & Modigliani, 1988; Reder & Anderson, 1982; Ross & Landauer, 1978; Whitten & Bjork, 1977). In addition it is recognised that retention is improved more by repeated successful attempts to retrieve items from memory (retrieval) than by the same number of repeated exposures or presentations alone (reminding) (Bjork, 1988; Bjork & Bjork, 1992; Buyer & Dominowski, 1989; Gotz & Jacoby, 1974; Hagman, 1983; Hogan & Kintsch, 1971; Modigliani, 1978; Moffat, 1984; Payne & Wenger, 1992; Rabinowitz & Craik, 1986; Rosner, 1970; Thompson, Wenger & Bartling, 1978; Wenger, Thompson & Bartling, 1980).

The success of retrieval trials in assisting memory has been demonstrated also in clinical populations. There have been several single-case studies in the literature involving people with brain impairments of various underlying causes being successfully taught specific pieces of information using repeated retrieval trials. Hanley (1986) used repeated retrieval trials to re-teach a dementing patient information about her husband's death in order to alleviate her confusion. Wilson (1982) taught a cerebrovascular accident patient to follow a daily timetable using repeated retrieval tests. Evidently there are empirical reasons for using retrieval trials for clinically enhancing memory.

Landauer & Bjork (1978) raised the suggestion that possibly the optimal schedule for retrieval trials would be a pattern of increasing intervals between successive trials rather than uniform presentations. That is, they proposed that a combination of retrieval trials and spacing during learning would be most conducive for later recall. The rationale behind their idea was that a first retrieval trial at a short interval would likely be successful and strengthen an item sufficiently to survive a slightly longer interval that would yield a more effective second practice trial. Ensuing experiments on healthy young adults confirmed that such "spaced retrieval" trials were more effective in assisting later retention of information than uniformly spaced retrieval trials.

Schacter and his colleagues (Schacter, Rich & Stamp, 1985) appear to have been the first to investigate the use of spaced retrieval as a mnemonic technique in clinical populations. They demonstrated that by commencing a series of retrieval trials at 90 seconds and then expanding the interval, they were able to teach four brain impaired subjects the association between faces and personal details, and that these associations were retained over twelve days.

Spaced retrieval was subsequently first used as an aid to acquisition in a patient suffering from dementia in 1989 (Moffat, 1989). In this study, a woman in her late 50s with Alzheimer's Disease was taught to name certain pictures using the spaced retrieval technique. Moffat reported success in his intervention - after this training, the lady was able to remember the names of the pictures after delay.

Since this initial clinical use of the technique, Cameron Camp and his associates (late 1980s, early 1990s) have conducted several studies on the spaced retrieval technique in Alzheimer's patients. Prior to Camp's work, it was standard practice to double the time interval on each retrieval trial, for example retrieval trials would be conducted at one minute, two minutes, four minutes etc. Camp and his colleagues have reported the need to use a much more gradually expanding schedule when using the technique with those with dementia. Generally Camp's studies involved conducting the first retrieval trial after an interval of approximately 10 seconds and then doubling these intervals until an interval of 60 seconds was reached. Following this, the intervals were expanded by an additional 30 seconds on each trial (60, 90, 120, 150 seconds...). If the subject failed to retrieve on any trial, they were reminded of the information and then given the next retrieval trial at the last successful retrieval interval.

Using this technique, Camp has been able to train Alzheimer's patients to learn an association between a staff members face and their name (Camp, 1989; Camp & Schaller, 1989; Camp & Stevens, 1990), the names of common objects (Camp & McKittrick, 1992), object-location associations (Camp & Stevens, 1990), a cue-task association (McKittrick, Camp & Black, 1992; Stevens et al. 1992), and a strategy for using external memory aids (Stevens et al. 1992). Although the technique did not work flawlessly for all types of learning and all individuals (Camp & Schaller, 1989), some patients were able to retain the learned information over many weeks (Camp,

1989; Camp & Schaller, 1989) and when relevant, later execute the learned strategy upon re-presentation of the cue (McKittrick et al; Stevens et al.).

Though the studies by Camp and associates illustrated spaced retrieval to be an effective mnemonic for certain individuals with dementia, no attempt was made to determine experimentally the critical factors in the technique. Importantly, no control conditions were employed to determine if these expanding retrieval trials were more effective than simple repetition in acquiring the information, or whether the expansion schedule was necessary for the effectiveness of the technique.

The lack of experimental evidence on the superiority of retrieval over simple repetition in dementia sufferers was recognised by Bird & Kinsella (1996). They conducted one study which compared these two conditions in dementia sufferers. Here individuals with dementia were taught an association between a cue (an alarm plus a written word e.g "glasses") and a task (e.g. put the glasses in the case) using retrieval trials conducted over expanding intervals of time (spaced retrieval) and then taught a different but comparable association using reminding trials conducted over expanding intervals of time (spaced reminding). Using a repeated measures design, they found that spaced retrieval was superior at assisting recall 24 hours later than was spaced reminding. These results suggest that retrieval trials are a necessary factor in the efficacy of the spaced retrieval technique.

Unfortunately, the various studies by Camp and associates and by Bird & Kinsella (1996) are not directly comparable. Failure to retrieve in Camp's studies were dealt with by reminding the person of the information and then reducing the next retrieval interval. In contrast Bird & Kinsella combined elaborative fading cues with retrieval trials; if an individual failed to retrieve the information at a particular time interval, the person was given elaborative cues until they could successfully retrieve, and then the next retrieval trial was conducted at a longer time interval. Therefore, even

though Bird & Kinsella have demonstrated the superiority of spaced retrieval over spaced reminding, their spaced retrieval technique also incorporated fading cues, another known mnemonic technique (Glisky & Schacter, 1987; Kazdin, 1984; Wood, 1992).

To date no-one has demonstrated experimentally whether spaced retrieval is more effective than spaced reminding trials in those with dementia using the exact technique developed by Camp. Additionally, no experimental support has been gained in the dementia population for whether or not it is necessary to conduct retrieval trials on an expanding schedule as opposed to using uniformly spaced trials. The majority of studies that have been conducted to date have been either anecdotal, single case studies and/or failed to provide control conditions with which to compare the effectiveness of spaced retrieval. It will be the aim of the present study to provide some experimental data relevant to these unknowns.

3.2 Theoretical Propositions Regarding the Efficacy of Spaced Retrieval as a Mnemonic Technique

Why would one expect spaced retrieval to be an effective mnemonic? Rea and Modigliani (1988) have stated that the efficacy of spaced retrieval as a mnemonic technique is hard to explain theoretically. The idea has been proposed that the technique may operate along the principles of a shaping paradigm applied to memory (Camp & McKittrick, 1992; Camp & Schaller, 1989; Landauer & Bjork, 1978). In this case, the goal is the infinite retention of new information and the ability to recall this information unaided after delays. Through the technique, the individual is successively approximating this desired goal on each trial and in the process, experiencing high levels of success during learning (Camp & McKittrick, 1992; Camp & Schaller, 1989; Landauer & Bjork, 1978).

A fundamental debate exists, however, regarding the type of processing that is applied to the to-be-remembered information during this shaping procedure. Two distinct schools of thought exist divided on how they see the technique as assisting acquisition of information in those with dementia. The first of these postulates cognitive effort is the factor essential for the success of the technique in both dementing and non-dementing populations (Bird & Kinsella, 1996; Bjork, 1988; Bjork & Bjork, 1992; Landauer & Bjork, 1978).

The second school of thought have queried the role of cognitive effort in spaced retrieval. It is claimed that this technique is automatic and non-effortful (Camp & McKittrick, 1992; Camp & Schaller, 1989; Camp et al. in press; Glisky, Schacter & Tulving, 1986; Schacter et al. 1985; Stevens et al. 1992), instead tapping implicit memory processes (Backman, 1992; Camp, 1989; Camp & McKittrick, 1992; Camp & Schaller, 1989; Camp & Stevens, 1990; Foss & Camp, in press; Glisky et al. 1986; McKittrick et al. 1992; Schacter et al. 1985; Stevens et al. 1992). Priming is one such implicit process currently being investigated (Camp & McKittrick, 1992). At present this debate remains largely theoretical with little research being directed at a resolution.

Probably one of the reasons for the lack of experimental studies attempting to test the assertions that cognitive effort is an important factor in the effectiveness of the spaced retrieval technique, is the difficulty of measuring cognitive effort.

Controversy exists regarding the best measures (Mitchell & Hunt, 1989), however it is known that if one wants to assess the relationship between cognitive effort and memory, independent indices of each are needed, otherwise findings will not be conclusive (Mitchell & Hunt, 1989). In light of this, reaction time to respond to a cue, or time taken to concurrently perform another task have been two such measures employed in an attempt to measure cognitive effort (Cuddy & Jacoby,

1982; Johnston & Uhl, 1976; Tyler et al. 1979). To date, no-one has attempted to directly measure cognitive effort employed during spaced retrieval.

In order to investigate further the question of why spaced retrieval should assist acquisition, it is necessary to look at the theoretical explanations given for the mnemonic efficiency of retrieval trials and spacing individually.

With respect to the mnemonic effect of retrieval trials, it has been proposed that the act of retrieving information requires cognitive effort (Bird & Kinsella, 1996; Bjork, 1988; Bjork & Bjork, 1992; Hagman, 1983; Izawa, 1992; Landauer & Bjork, 1978). Cognitive effort during acquisition has been claimed to be one method of ensuring the laying down of a discriminable memory trace (Jacoby & Craik, 1979). Studies have shown that cued recall is enhanced by manipulations at acquisition that require cognitive effort (Bird & Luszcz, 1991; Bird & Luszcz, 1993; Buyer & Dominowski, 1989; Diesfeldt, 1984; Glisky & Schacter, 1987; Herlitz, Adolfsson, Backman & Nilsson, 1991; Tyler et al. 1979). Bird & Kinsella (1996) have shown that the act of retrieval does appear to assist processing of the material and have suggested inducing subjects to undertake retrieval of to-be-learned material may compensate for the deficiency in controlled processing characteristic of senile dementia.

Several lines of investigation provide evidence for the role of cognitive effort in retrieval. Research has shown that retention of information is improved if successful retrieval during learning is achieved with minimal cues (Buyer & Dominowski, 1989). Providing only minimal cues ensures that the individual must expend cognitive effort in order to retrieve the information.

Further, cognitive effort has been proposed as an important contributing factor to the superior recall of internally generated information over externally provided information (Buyer & Dominowski, 1989; Tyler et al. 1979), and to the fact that this

phenomenon is substantially stronger for subjects who had to work harder to generate the item initially (Buyer & Dominowski, 1989). As retrieving information is akin to an internally generated response, one can infer that cognitive effort may also contribute to the efficacy of retrieval trials.

Although the role of cognitive effort in the mnemonic effectiveness of retrieval trials has not been investigated systematically nor experimentally in the dementing elderly, this is a widely accepted explanation for why retrieval has a mnemonic effect in the non-dementing population.

Aside from cognitive effort, other researchers have asserted that retrieval trials may assist later recall of information as they allow an active reprocessing of the item (Landauer & Bjork, 1978; Thompson et al. 1978), they help prevent forgetting (Izawa, 1992), and they provide practice in gaining access to the trace therefore making it more distinctive (Bjork, 1988; Izawa, 1992; Landauer & Bjork, 1978). Additionally claims have been made that the act of retrieval does not actually strengthen the representation of the item in memory, but it enhances some aspect of the retrieval process per se, thus making delayed retrieval easier (Bjork, 1988; Izawa, 1992). Still others have suggested that the efficacy of retrieval trials in enhancing later recall may lie in a combination of cognitive effort and several of the above-mentioned factors (Izawa, 1992).

Theoretically, debate also still exists regarding the efficacy of the spacing effect. Two major classes of theories have been posited, divided on how they see spacing of trials assisting memory. The first class of theories are referred to as encoding theories, while the second class are referred to as processing theories (Dellarosa & Bourne, 1985). Some experimental support has been found for the role of encoding factors in the spacing effect (Bjork & Allen, 1970; Gartman & Johnson, 1972; Glenberg, 1979; Hintzman & Block, 1970; Tzeng, 1973), while others have found

processing factors appear to play a more important role (Dellarosa & Bourne, 1985; Hintzman, 1974; Ross & Landauer, 1978).

Encoding theories attribute the spacing effect to the increased independence of encoding events when intervals are increased between repetitions (Dellarosa & Bourne, 1985; Hintzman, 1974; Toppino & Gracen 1985, as cited in Dempster, 1988). These theories suggest that two presentations of an event are encoded equally strongly in memory regardless of their spacing. However, as the spacing of repetitions increases, so too does the chance that these repetitions will be encoded differently. This differential encoding is believed to somehow assist retrieval processes (Hintzman & Block, 1970).

Processing theories, on the other hand, assume that recall is a function of the amount of processing carried out on the information (Dellarosa & Bourne, 1985). They attribute the poor recall of massed repeated items to a failure to process one or both of the presentations fully, and the superior recall of spaced presentations to an attenuation of processing of one or both presentations when the presentations are temporally further apart. Within the processing theories, some have posited neurological mechanisms as being responsible for the deficient processing of massed items (see Hintzman, 1974 for a review; Landauer, 1969; Peterson, 1966), while others attribute this deficient processing to a conscious decision on behalf of the individual to either not attend to, or not fully process, each repetition during massed presentations (see Hintzman, 1974 for a review).

As noted above, one important factor believed to contribute to the attenuated or deficient processing of spaced and massed repetitions respectively is, again, cognitive effort. The importance of cognitive effort to the efficacy of the spacing effect and the schedule of such spaced trials has been claimed by a number of authors (Bjork, 1988;

Bjork & Bjork, 1992; Johnston & Uhl, 1976; Landauer & Bjork, 1978; Melton, 1967; Mitchell & Hunt, 1989).

According to this hypothesis, it is necessary for an item to be partially forgotten or not readily accessible in order for a second repetition or test-trial to be maximally effective (Cuddy & Jacoby, 1982; Melton, 1967). If two repetition or retrieval trials are presented close together, less processing is carried out on the second trial due to residual accessible traces from the first (Bjork & Bjork, 1992; Cuddy & Jacoby, 1982; Dempster 1988; Landauer, 1969). This decreased level of processing on the second trial results in weak encoding. As the spacing between trials is increased, the trace from the first presentation has weakened (Cuddy & Jacoby, 1982), the ability to retrieve it has decreased, more effort must be put into retrieving, and therefore the second presentation will be processing further (Atkinson & Shiffrin 1974, as cited in Foos & Smith, 1974; Dellarosa & Bourne, 1985; Glanzer, 1969; Ross & Landauer, 1978). Thus forgetting or partial forgetting during learning ensures that later repetitions receive full effortful processing and consequently that delayed recall will be enhanced (Cuddy & Jacoby, 1982; Dempster, 1988; Hintzman, 1974).

With regard to the spacing schedule in spaced retrieval, Bjork (1988; Bjork & Bjork, 1992) has explicitly argued that the theoretically optimum interval between retrieval trials would be just before the information is lost. That is, it is still accessible but maximum effort is required to retrieve it. Thus, ironically, items which are more difficult to recall initially will be more likely to be recalled at delay (Gardiner, Craik & Bleasdale, 1973; Whitten & Bjork, 1977). Small time intervals between retrieval trials are necessary initially to ensure there is a high probability of successful recall (Izawa, 1992; Modigliani, 1978), but then as the interval is increased, greater effort is required for successful retrieval and thus the probability of successful delayed recall is increased (Modigliani, 1978).

As already noted, it has been shown that cognitive operations requiring conscious effort do assist subjects with dementing illness to acquire new material (Bird & Luszcz, 1993; Diesfeldt, 1984), even though methods such as repetition or mnemonics are ineffective for this population. If the effort hypothesis is valid for either the spacing effect or the retrieval effect or both, it might therefore explain why spaced retrieval is also an effective acquisition aid in dementia. However, this is not known; the active components of spaced retrieval have not been systematically investigated with dementing populations. In particular, it is not known whether both spacing and retrieval are necessary with these subjects, nor whether cognitive effort contributes to the effectiveness of spaced retrieval. These questions are the focus of the current study.

3.3 The Present Study

From the preceding review, it is possible to identify several areas of contention. First, does spaced retrieval have a mnemonic effect in those elderly with dementia? Second, does the act of retrieval have an active role in the efficacy of the technique? Third, is expanding the intervals in the spaced retrieval technique a necessary component of its mnemonic effect in this population? Finally, does cognitive effort appear to be a plausible theoretical explanation for the effectiveness of spaced retrieval?

The present study attempted to answer these questions using a face-name association learning paradigm. Face-name associations have been used in previous studies examining spaced retrieval in dementia subjects (Camp, 1989; Camp & Schaller, 1989; Camp & Stevens, 1990). Two methods of presenting the association were used: repeated retrieval trials (*retrieval*), and reminding trials where subjects were repeatedly presented with the face-name association (*reminding*). Two types of

interval schedule were used to conduct these retrieval or reminding trials on: uniformly spaced trials (*massed*) and trials of expanding intervals (*spaced*).

Support for the active role of retrieval trials in spaced retrieval would be found if recall of information learned using *spaced retrieval* trials were superior to recall of information learned using *spaced reminding* trials. Additionally, if recall of information learned using spaced retrieval trials were superior to recall of information learned using *massed retrieval* trials, this would support the proposal that spacing of the retrieval trials is a necessary active factor in the efficacy of the spaced retrieval technique. Furthermore, if spaced retrieval trials were superior to both massed retrieval trials and spaced reminding trials, this would provide support for the efficacy of spaced retrieval as a mnemonic technique for those with dementia. A superiority of all other conditions over the baseline condition, *massed reminding*, would show that both spacing and retrieval, separately, have a mnemonic effect with this population.

It was necessary to use cued recall as the outcome measure. As noted, free recall with this population is not normally sensitive to manipulations undertaken at encoding (Bird & Luszcz, 1991; Diesfeldt, 1984). The criterion test was ability to recall the name when the face was re-presented one hour after the training session. One hour was selected as a clinically significant interval. Bird and Kinsella (1996) have shown that information recalled by dementing subjects after one hour is then retained for significantly longer periods. The dependent variable was number of progressively revealed letters of the name (that is, alphabetical recall cues) required by the subject before successful one hour recall occurred.

With respect to the role of cognitive effort in spaced retrieval, the cognitive effort required to make a response can be implied by time taken to respond. If information is available automatically, no search through memory is needed so flat reaction time

functions are expected. On the other hand when information is not available automatically, effort must be put into retrieving and consequently linear reaction time functions are expected (Schneider & Shiffrin, 1977). Accordingly, if there is a trend for the time taken to recall information to increase as the length of the interval between active attempts at retrieval increases, this would support the notion that cognitive effort is responsible for the effectiveness of the spaced retrieval technique. Further support for such a conclusion would be provided by a finding of no such relationship in an encoding condition that contains retrieval trials conducted on a massed interval schedule. In this case one would expect cognitive effort to remain constant on the average for each retrieval trial, as time between trials is constant.

In summary, subjects were trained to learn four different face-name associations using four different encoding techniques. The four techniques differed in whether or not they contained active attempts to retrieve the to-be-remembered information (retrieval trials versus reminding trials) and/or whether or not learning trials during the training phase were presented at expanding time intervals (spaced versus massed). Response time at each trial in the two retrieval conditions, spaced retrieval and massed retrieval, was also recorded.

3.4 Experimental Hypotheses

Based on the preceding review of the literature, the following hypotheses were generated:

1. Fewer alphabetical recall cues would be needed to elicit the correct name on re-presentation of the face one hour after training, if subjects were taught the face-name association using spaced retrieval trials rather than spaced reminding trials.

2. Fewer cues would be needed to elicit the correct association following training using spaced retrieval, than following training using massed retrieval.

In summary, it was hypothesised that spaced retrieval, which combines retrieval with a spaced interval schedule, would be superior to all other conditions.

3. If cognitive effort is a valid explanation for the efficacy of spaced retrieval as a mnemonic technique for those with dementia, then the time taken for the subject to recall the face-name association on each retrieval trial during the training phase should increase as the inter-trial interval for these retrieval trials increases. It would be expected that time taken to retrieve the association on each retrieval trial conducted on a massed interval schedule would show no incremental trend, as time between retrieval trials is constant.

4.0 Experiment.

This experiment compared four different methods of acquisition of a face-name association. The aim was to see whether a face-name association acquired using active retrieval trials conducted on a spaced interval schedule would be remembered better than those associations learned using reminding of material and/or massed interval schedules.

4.1 Method

Subjects learned a face-name association and subsequently recalled the name when the face was re-presented to them following a one hour delay. This association was taught to them using one of four different techniques. These four techniques were spaced retrieval, spaced reminding, massed retrieval and massed reminding.

The subjects were visited five times in all, each visit separated by at least three days in order to eliminate the possibility of carry-over effects. There was a pre-test session to gather data for individualised parameters (number of trials and spacing) for each subject, and then one visit for each of the four experimental conditions. All subjects received all four conditions and within the limits of sample size, allocation of condition to visit, and allocation of experimental stimuli to condition, was counterbalanced between subjects.

Subjects and Diagnosis.

Subjects were recruited from nursing homes and special aged care units throughout the A.C.T and neighbouring regions. Initially, residents who were judged by nursing staff to be dementing and testable were nominated as potential experimental subjects. Consent for participation was obtained in the first instance from relatives. Nursing home directors contacted relatives and requested permission for experimenter contact. A letter of explanation was subsequently sent to relatives and they were required to complete a written consent form. Three relatives declined to give consent. Permission for testing was also obtained verbally from the residents themselves immediately prior to each testing session and following a description of what the testing would involve.

These subjects were then diagnosed using the NINCDS-ADRDA criteria (McKhann et al. 1984). Full criteria relating to diagnosis of *probable* and *possible* Alzheimer's Disease are presented in Appendix I (Table 1). Basic requirements consist of the administration of a cognitive screening test, evidence of neuropsychological impairment in two or more cognitive areas (at least one of which must be memory) as determined from a performance in the lower 5th %ile of a matched control group, onset after age 40, evidence of temporal decline, and elimination of plausible alternative explanations for the symptoms.

In addition to those believed to be dementing, nursing staff also nominated residents whom they believed to be free of behavioural or cognitive functioning indicative of a dementing illness for use as control subjects. Control subjects did not participate in the experiment proper, but following NINCDS-ADRDA recommendations, were merely administered the neuropsychological test battery in order to provide comparative neuropsychological data to assist diagnosis of the dementing subjects. Consent was obtained from these control subjects in writing following an explanation of the nature of the testing.

Nursing home files, information from nursing staff and hospital medical files were used to screen potential subjects for alcohol abuse, recent head injury, recent operations, depression, systemic illness, and in the case of the experimental subjects, dementing illness other than Alzheimer's Disease or Vascular Dementia.

Additionally, a measure of daily behaviour was derived from the Mental Disorganisation/Confusion scale (MENT) of the London Psychogeriatric Rating Scale (Hersch, Kral & Palmer, 1978) which nursing staff were required to complete.

Of those residents nominated by nursing staff as having a dementing illness and from whom a relatives' consent was obtained, one was too ill to participate, three were later found to be undergoing treatment for concurrent depression, four refused to participate, three were determined upon initial discussions to be too badly impaired to test, four were commenced but discontinued due to an inability to perform the experimental tasks, one was later diagnosed as having Pick's Disease, and two failed to meet the NINCDS-ADRDA criteria for cognitive impairment.

Of those subjects nominated as potential control subjects, six were excluded; three due to borderline performance on the general screening instrument (MMSE), one had English as a second language, and two were borderline in cognitive performance.

The final sample consisted of 13 subjects (2 males and 11 females) with dementia and 20 (14 females and 6 males) controls. The mean age of those with dementia was 83 years with a range of 63 to 94 years. Control subjects had a mean age of 85.95 years with a range of 75 to 102 years. These two groups did not differ on age ($t(31)=0.21$, $p>.05$), nor on estimates of premorbid intelligence ($t(27)=0.76$, $p>.05$) obtained from error scores on the National Adult Reading Test (NART; Nelson & McKenna, 1975; Willshire, Kinsella & Prior, 1991). The NART is considered the best test to use to estimate premorbid levels of functioning in those with dementia as it causes them

little anxiety to complete, it provides at worst a lower limit of premorbid intelligence, intelligence levels predicted from it approximate closely true premorbid levels in all but the severest cases, the effects of dementia on performance on the test are negligible unless severely dementing, and it has high reliability (Christensen, Hadzi-Pavlovic & Jacomb, 1991; Lezak, 1983; Nelson & McKenna, 1975; Spreen & Strauss, 1991). Two dementing subjects and one control subject were unable to read the words in the NART, and one subject with dementia refused to complete the test. Of these four, all were estimated to have been in the average range of intelligence premorbidly based on prior occupations.

Neuropsychological Testing

The battery of tests chosen for diagnostic purposes were selected, first, to sample a wide range of cognitive functions which are known to decline in the early stages of dementia, and secondly, to take into consideration the further difficulty those who are more impaired have due to fatigue and slowed information processing.

The test battery consisted of:

1. Mini-Mental Status Exam;
2. Logical Memory Subtest of the Wechsler Memory Scale;
3. Fuld Object Memory Evaluation Test;
4. Digit Span subtest of the Wechsler Adult Intelligence Scale Revised;
5. Part A of the Trail Making Test;
6. Boston Naming Test;
7. Controlled Oral Word Association Test;
8. Similarities subtest of the Wechsler Adult Intelligence Scale Revised;
9. Clock Drawing Test.

1. Mini-Mental Status Exam (MMSE: Folstein, Folstein & McHugh, 1975). The MMSE is the most widely administered dementia screening instrument and is used to assess orientation, recall, praxis, calculation and language (Christensen et al. 1991; Ferris, 1992). Despite some recognised problems (Folstein, Anthony, Parhad, Duffy & Gruneberg, 1985; Pfeffer et al. 1981), the MMSE is often used as a rough general measure of impairment level (Folstein et al. 1975; Herlitz et al. 1991; Karlsson et al. 1989; Kay, Henderson, Scott, Wilson, Rickwood, & Grayson, 1985; Lezak, 1983; Walsh, 1978) and it tests cognitive function simply and quickly in a population known to have concentration problems (Lezak, 1983; Spreen & Strauss, 1991).

2. Memory Tests. Several different aspects of memory were assessed, necessitating the use of various measures of memory. The Logical Memory Subtest of the Wechsler Memory Scale Revised (WMS-R; Wechsler, 1987) was used to assess both immediate and delayed memory for prose, object memory was assessed by the Fuld Object Memory Evaluation Test (Fuld, 1980), and short term and working auditory memory was assessed using the Digit Span subtest of the Wechsler Adult Intelligence Scale Revised (WAIS-R; Wechsler, 1981). Each of these tests or subtests have been shown to be sensitive to brain deterioration and memory disturbances (Berg et al. 1994; Golden, 1990; Kopelman, 1986a; Reid, 1994; Spreen & Strauss, 1991) and to discriminate between mildly demented and healthy aged groups (Fuld, Masur, Blau, Crystal & Aronson, 1990; Kaszniak, 1986; Storandt & Hill, 1989), although studies with dementing elderly show performance on digit span is often within normal limits in the early stages of the disease (Walsh, 1978).

3. Part A of the Trail Making Test. This test was administered as a measure of visuo-motor tracking and attention. This test is considered vulnerable to the effects of brain injury (Lezak, 1983) and is a sensitive test of brain dysfunction (Berg et al. 1994; Golden, 1990), discriminating the brain injured from normal controls with a hit rate of approximately 85% (Golden, 1990). Reliability is also found to be very high

(Charter et al. 1987, as cited in Spreen & Strauss, 1991; Lezak, 1983; Snow et al. 1988, as cited in Spreen & Strauss, 1991).

4. Language. Confrontation naming and verbal fluency were used to assess language as measured through the Boston Naming Test and the Controlled Oral Word Association Test (Goodglass & Kaplan, 1984) respectively. Both of these tests have been shown to have good reliability (Huff et al. 1986, as cited in Spreen & Strauss, 1991; Snow et al. 1988, as cited in Spreen & Strauss, 1991), to be receptive measures of brain dysfunction (Lezak, 1983; Martin & Fedio, 1983) and to be sensitive to the early stages of dementia (Flicker, Bartus, Crook & Ferris, 1987; Hart, Smith & Swash, 1988; Murdoch, Chenery, Wilks & Boyle, 1987).

5. Similarities subtest of the WAIS-R (Wechsler, 1981). This test was administered as a measure of mental flexibility and verbal concept formation. These functions are known to be adversely affected by deterioration in brain functioning (Golden, 1990).

6. Clock Drawing Test (Wolf-Klein, Silverstone, Levy, Brod & Breur, 1989). This test was administered as a screening task for visuo-spatial and constructional problems. This test is frequently recommended for use as a screening tool for dementia as it can discriminate between dementing and non-dementing elderly (Libon, 1993; Tuokko, Hadjistavropoulos, Miller & Beattie, 1992), it has a correct classification rate of 87% and a specificity of 97% for those with dementia (Wolf-Klein et al. 1989) and has high interrater reliability (Spreen & Strauss, 1991).

Delayed recall in both the prose passage and the Fuld Object Memory Test took place approximately 10 minutes after immediate recall. Order of administration of this comprehensive test battery varied randomly between subjects.

Standard instructions and administrative procedures were always followed for control subjects, and wherever possible with those with dementia. Simplification of instructions or provision of more examples was given as needed to dementing subjects. This was justified by: (a) the main aim of testing being to sample a range of cognitive functions rather than an understanding of, and memory for, instructions; and (b) the fact that obtaining an accurately diagnosed subject pool was not compromised, as these deviations from standard procedure would only result in an increased risk of false negatives and not false positives.

Table 1 presents summary demographic information and test battery results for both dementing and control subject groups. Raw demographic and neuropsychological assessment scores can be found in Appendix II (Tables 1, 2 and 3). Certain subjects did not participate in the full battery of tests. This was due to either poor eyesight, problems with motor control, and/or refusal to complete.

Table 1

Group Means, Standard Deviations, Score Ranges, t-values and Significance Levels
for Demographic Information and Neuropsychological Test Battery Results.

	Controls			Dementia			t-value
	N	Mean (Range)	SD	N	Mean (Range)	SD	
age	20	85.95 (75-102)	7.529	13	83.00 (63-94)	7.969	0.206
nart	19	107.895 (93-124)	8.608	10	105.6 (99-117)	5.758	0.76
mmse	20	27.9 (25-30)	1.683	13	14.846 (8-19)	3.783	13.58*
lm-1	19	9.947 (5-17)	3.10	13	1.846 (0-6)	1.951	8.34*
lm-2	19	7.684 (2-17)	4.295	13	0.231 (0-1)	0.439	6.202*
fuld	19	5.737 (2-8)	1.727	12	1.00 (0-2)	0.853	8.81*
ds-f	20	6.65 (4-12)	1.954	13	5.846 (3-11)	2.478	1.04
ds-b	20	5.95 (3-11)	2.038	12	4.667 (3-7)	1.231	1.97
boston	18	45.333 (26-55)	8.858	11	23.091 (12-37)	8.538	6.65*
fas	20	29.6 (13-49)	9.196	12	17.5 (2-53)	14.19	2.94*
sim	20	11.85 (2-24)	6.335	13	3.769 (0-12)	4.024	4.08*
trails	18	54.5 (18-141)	29.93	10	182 (68-312)	98.886	-5.13*
clock	19	8.579 (6-10)	1.539	11	5.455 (2-10)	2.252	4.52*

*p < 0.05

where nart = premorbid intelligence estimated from the national adult reading test, mmse = mini-mental state exam, lm-1 = prose passage immediate recall, lm-2 = prose passage delayed recall, fuld = fuld object memory test, ds-f = digit span forwards, ds-b = digit span backwards, boston = boston naming test, fas = verbal fluency - controlled word association test, sim = similarities, trails = trail making test-A, clock = draw a clock test.

An examination of the relationship between the MMSE and other neuropsychological tests in the battery reveal significant correlations with the measures of language (confrontation naming and verbal fluency), visuo-spatial and constructional ability and short-term and working auditory memory (Pearsons r range = .48 to .81). In addition, MMSE scores did not overlap between the dementing and control subjects, and in those with dementia, a significant negative correlation existed between scores on the MMSE and the measure of daily behaviour (MENT). This negative correlation implies that their cognitive impairments are severe enough to interfere with their ability to perform a range of day to day activities. The full correlation matrices can be found in Appendix III (Table 1). These findings validate use of the MMSE as a general measure of level of impairment for this sample.

As shown in Table 1, digit span (forwards and backwards) was the only subtest that failed to discriminate between the dementing and control groups. Of the thirteen experimental subjects, twelve qualified for a diagnosis of probable dementia and one for a diagnosis of possible dementia based on NINCDS-ADRDA criteria.

Medical records held in nursing homes, information from nursing staff and personal medical history obtained from subjects themselves were initially gathered to complete the Psychogeriatric Assessment Scale (PAS; Jorm & McKinnon, 1994). According to the PAS, ten subjects had profiles more consistent with that expected in Alzheimer's Disease, while three had profiles more consistent with a vascular type dementia. Upon further discussions with a diagnosing geriatrician, the profile for two subjects originally diagnosed as Alzheimer's Disease became more consistent with a vascular dementia profile, thus resulting in six subjects with vascular dementia consistent profiles, and seven with an Alzheimer's Disease consistent profile.

Materials and Apparatus.

Five colour photographs measuring 10 * 14 centimetres were used as the main experimental stimuli. These photographs showed a head and shoulder shot of a middle aged man, a middle aged woman, an elderly woman, a teenaged male and a young male in his mid twenties. The photographs were easily distinguishable. Photographs and names are presented in Appendix IV where it will be seen that the surnames were all seven or eight letters in length. Additional materials included a stopwatch for use by the experimenter, a clipboard used by the subjects to lean on during writing tasks, and pre-prepared record sheets for registering training phases and subject response times (see Appendix V). A complete set of neuropsychological test battery record forms was also required for each subject.

Experimental Design.

The main experimental design was a counterbalanced mixed factorial repeated measures design. The main within subjects factor was encoding condition. The four levels of this factor were spaced retrieval, massed retrieval, massed reminding and spaced reminding. Although this design may be conceptualised as a 2 * 2 design, the decision was made to treat it as a one-way design as the main question being asked was whether subjects' memory for face-name associations learnt using retrieval trials conducted on a spaced interval schedule (spaced retrieval) was superior to their performance when taught these associations using various individual components of spaced retrieval. Knowledge of the efficacy of spaced retrieval as a technique is clinically more relevant than knowledge of the action of the two individual factors.

A between subjects factor, included to provide data of more clinical interest, was level of impairment as determined by scores on the MMSE. As the scores on the MMSE are continuous, cut-off points are arbitrary (Kay et al. 1985) and the decision was made to use a median split to divide subjects into two groups (low versus high level of impairment). A subsidiary between subjects factor was diagnosis (two

levels); Alzheimer's type dementia or vascular dementia. To control for order and experimental stimulus effects, two subsidiary between subject factors were encoding condition order (four levels) and face-name association order (four levels).

The role of cognitive effort was examined using a 3*2 repeated measures factorial ANOVA with the two retrieval encoding conditions (massed versus spaced) and training session trial stage (initial, middle or final) as within subjects factors.

The experiment proper consisted of four counterbalanced experimental conditions (spaced retrieval, spaced reminding, massed retrieval and massed reminding). In addition, a pre-test spaced retrieval condition was also administered to each subject. This pre-test was needed to determine the individual template for spacing and retrieval required by each subject in the experimental conditions proper. Spaced retrieval, as adapted for the severely impaired and variable populations found in dementia, is by necessity and by definition highly patient-specific, yoked to the subject's learning rate (Camp & McKittrick, 1992; Camp & Schaller, 1989).

This pre-test provided information on the number of retrieval trials each subject required, and the expansion schedule necessary for them to reach an inter-trial retention interval of 240 seconds. Camp and associates have found such an interval sufficient for later long-term recall (Camp, 1989; Camp & Schaller, 1989; Stevens et al. 1992). This information was then used to set and match the number of trials given in each subject's massed reminding, massed retrieval and spaced reminding conditions, as well as the rate at which intervals increased between trials in spaced reminding. Such matching was necessary in order to allow only retrieval/reminding and spaced/massed to vary between each experimental condition. Only a preliminary spaced retrieval trial could provide the information to set these parameters for other conditions but it was necessary to make it a dummy run as administering spaced retrieval first for all subjects in the experiment proper would compromise

counterbalancing. It was assumed that mean pre-test spaced retrieval and experimental spaced retrieval results would be equivalent, thus these two conditions did not require matching. Confirmation of this assumption by statistical testing would justify use of the counterbalanced experimental spaced retrieval results in the final analysis of the data.

Procedure.

Subjects were taught an association between a photograph and the surname of the person in the photograph using one of four different techniques (spaced retrieval, spaced reminding, massed retrieval and massed reminding). Though the main experimental manipulations were standard, the number of trials and intervals between trials were tailored to each subject's ability based on the data obtained during the pre-test session.

a) Initial Visit:

The initial visit was used to determine the individual learning parameters required by each subject for the experimental conditions proper. This was done by (a) administering the dummy spaced retrieval learning session (pre-test); and (b) by establishing each subject's maximum retention interval for new information.

For the pre-test spaced retrieval, the subject was taught a face-name association by being asked to recall the name on a spaced interval schedule. During the training phase, all retrieval trials were free recall trials. Free recall was used first in keeping with procedures originally developed by Camp, and second to ensure that conclusions drawn regarding the mnemonic efficacy of pure spaced retrieval are not contaminated by additional mnemonic techniques, namely cueing.

Prior to the experiment commencing, subjects were informed of the nature of the experiment and their consent obtained. Each subject was then presented with a

three-letter stem of the surname they were to be taught, and asked to state the first surname that came to mind when presented with the stem. This was used to ensure the surname being taught was not one that would be given spontaneously without any training.

Subjects were then presented with a photograph of a face and verbally given the surname of the person in the photo. They were then repeatedly tested on their ability to immediately verbally recall the name given the face until this was done successfully. Subsequent retrieval trials were then conducted after five seconds, ten seconds, twenty seconds, forty seconds and sixty seconds, with following retrieval trials being expanded by an additional thirty seconds on every trial. Each trial was considered complete when the individual either correctly retrieved the name, or when they stated twice, in response to questioning, that they were unable to recall the name.

In the case of an incorrect response at a certain inter-trial interval (t_i), the standard spaced interval schedule was adjusted according to the procedure developed by Camp. The face-name association was re-presented to the subject and the next retrieval trial was then cued at the last successful retention interval (t_s). If successful here, the next retrieval trial was conducted at $(t_s + (t_i - t_s)/2)$. If success was again achieved, the subject was re-tested at the interval that was originally failed (t_i). If now successful at this previously failed interval, the subject was placed back on the regular expansion of the schedule. This process was continued until the subject was able to reach an inter-trial retention interval of 240 seconds. Figure 1 illustrates the training schedule of a hypothetical subject who failed on trial six attempting an inter-trial interval of ninety seconds, and eventually attains 240 seconds after 14 trials.

One hour subsequent to the training session, the subject was re-presented with the photograph and asked to recall the name. A response was considered incorrect if the

subject either recalled an incorrect name, or if they stated twice in response to questioning that they were unable to recall the name. Progressive letters in the surname were revealed, one following each incorrect response, until the correct name was recalled.

The other parameter it was necessary to establish prior to the experiment proper was each subject's maximum retention interval for newly presented information. Subjects were presented with a piece of information such as the experimenter's name or the temperature forecast for the day, and asked to recall it after a 30 second delay. If retrieval was unsuccessful, they were presented with a new piece of information, and the time before they were asked to retrieve it was reduced by five seconds. This procedure continued until they were able to successfully retrieve three different pieces of information at a particular retention interval. This maximum retention interval was then used as their individually tailored uniform inter-trial interval in both their massed retrieval and massed reminding conditions.

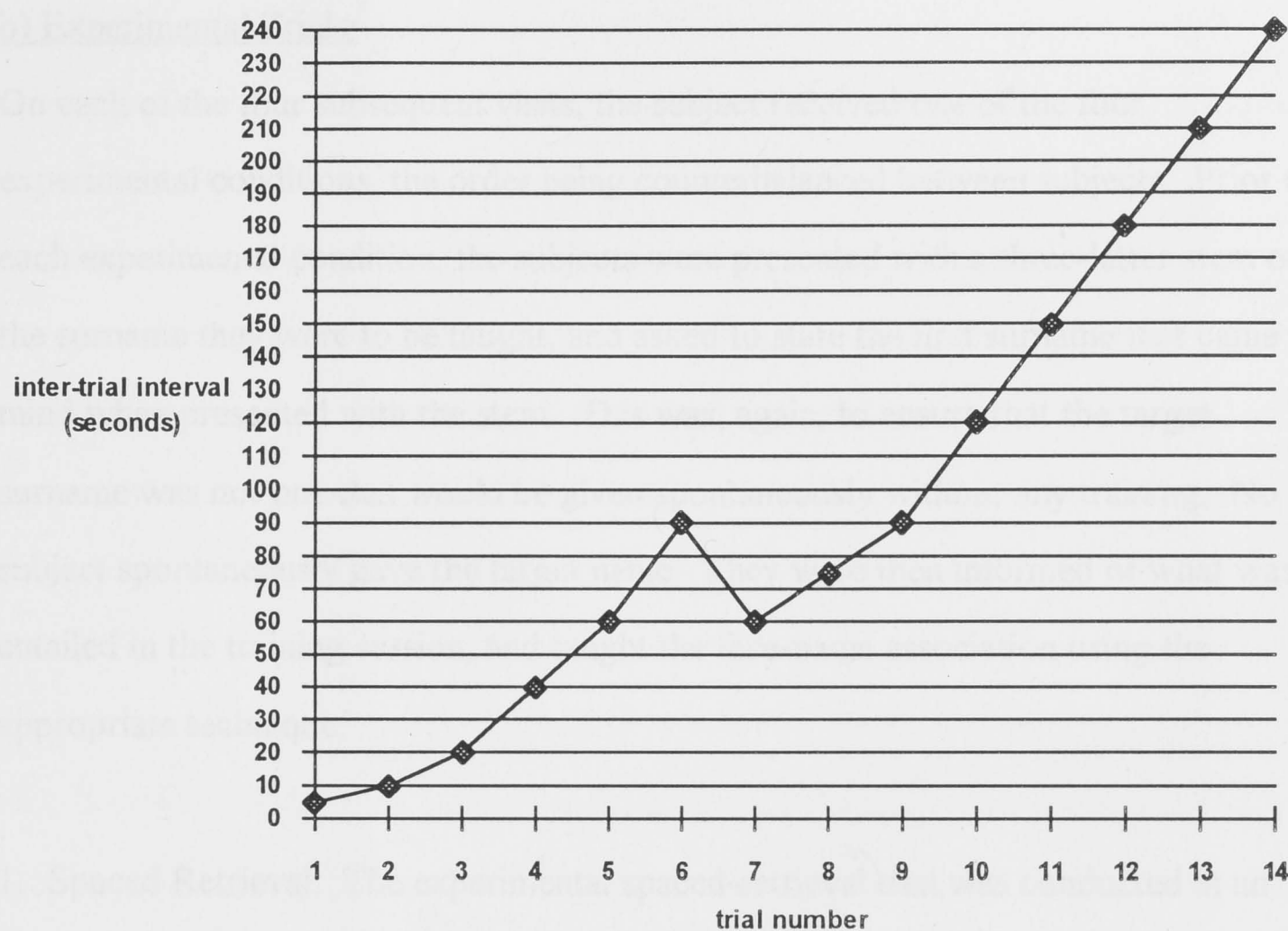


Figure 1. A representation of a hypothetical subjects training schedule in the pre-test spaced retrieval condition.

To illustrate the application to the experiment proper of the information gained at pre-test using the hypothetical subject illustrated in Figure 1, assume that the maximum retention interval for newly presented information was found to be 15 seconds. In the massed retrieval condition the subject would be given 14 retrieval trials, each 15 seconds apart. In the massed reminding trial, the subject would be reminded of the association 14 times, each one separated by 15 seconds. In the spaced reminding condition, the subject would be reminded of the association 14 times at the same expansion schedule used in the pre-test spaced retrieval condition. Finally the experimental spaced retrieval condition would be administered independently, free of matching, due to the assumption of equivalence between it and the pre-test performance.

b) Experimental Trials:

On each of the four subsequent visits, the subject received one of the four experimental conditions, the order being counterbalanced between subjects. Prior to each experimental condition, the subjects were presented with a three-letter stem of the surname they were to be taught, and asked to state the first surname that came to mind when presented with the stem. This was, again, to ensure that the target surname was not one that would be given spontaneously without any training. No subject spontaneously gave the target name. They were then informed of what was entailed in the training session, and taught the face-name association using the appropriate technique.

1. Spaced Retrieval. The experimental spaced-retrieval trial was conducted in an identical manner to the pre-test spaced retrieval trial. In addition, the time taken for each subject to recall the name after the face was exposed on each learning trial was also recorded using the stopwatch.
2. Spaced Reminding. Subjects were taught the association by being reminded of the name on a spaced interval schedule. They were presented with a different face-name association and tested on their ability to immediately recall the name given the face. They were then reminded of this face-name association on the same expanding inter-trial interval schedule used in their pre-test spaced retrieval condition.
3. Massed Retrieval. Subjects were presented with a different face-name association and again tested on their ability to immediately verbally recall the name given the face. They were then presented with the same number of free recall retrieval trials as in their pre-test spaced retrieval condition, but these were presented on a massed interval schedule. The uniform time interval used for these massed trials was determined individually during the initial visit where the subject's short term memory

span for newly presented information was ascertained. The time taken for each subject to recall the name after the face was exposed on each trial was also recorded.

4. Massed Reminding. Subjects were presented with a different face-name association and tested on their ability to immediately verbally recall the name when the face was exposed. They were then reminded of this association on a massed interval schedule matched to the number of trials needed in their individual spaced retrieval condition and at the same inter-trial intervals used in the other massed condition.

One hour after each of the four training sessions, subjects were re-presented with the face and, where required, progressively cued with the letters of the surname until it was recalled. The number of alphabetical cues required under each condition was the dependent variable.

4.2 Results

All analyses were performed using the Statistical Package for the Social Sciences (SPSS) Release 4.0 for Macintosh. Number of cues required for each subject to correctly recall the name when presented with the face 60 minutes after training under each experimental condition are presented in Appendix VI (Table 1).

Encoding Condition Effects.

Examination of frequency distributions for the number of cues required to retrieve the name following training under each of the experimental conditions revealed that some cases were potentially univariate outliers. However these were retained during analysis, as the small sample size meant that dealing with these outliers would have reduced power and altered results. Reliable identification of outliers was also difficult due to the small sample size.

One of the frequency distributions displayed significant kurtosis but since ANOVA is reasonably robust to violations of such assumptions, it was decided to leave this untransformed. The remaining frequency distributions displayed no significant skewness or kurtosis.

Pre-test versus experimental spaced retrieval. As explained earlier, the pre-test spaced retrieval trial was necessary to set the parameters for all four experimental conditions. This procedure was based on the assumption that, for the sample as a whole, the pre-test spaced retrieval condition and the experimental spaced retrieval condition would be equivalent either in mean number of trials needed to reach criterion or in mean cues required at delayed recall. A dependent groups t-test revealed no significant difference between the pre-test and experimental spaced retrieval conditions in the number of cues required to recall the name following delay, $t_{(12)} = -1.85$, $p > .05$. A second dependent groups t-test additionally revealed no significant difference between pre-test and experimental spaced retrieval encoding conditions on the number of trials required to reach criterion (240 second retention interval), $t_{(12)} = 1.03$, $p > .05$. Raw data are shown in Appendix VI (Table 2). This justifies use of the counterbalanced experimental spaced retrieval results in all analyses.

Subsidiary Factors. There were five possible photograph and name counterbalancing orders. Face-name order was entered as a 5 level between subjects factor into a repeated measures analysis of variance (Appendix VII, Table 1) incorporating the main within subjects factor (4 levels). There was no significant photo/name order effect ($F_{4,8} = 0.18$, $p > .05$) and no interaction with the experimental factor ($F_{12,24} = 1.07$, $p > .05$). It is concluded that performance in the four experimental conditions was not confounded with face or name order effects.

There were four possible encoding condition presentation orders. Encoding condition order was also entered as a four-level between-subjects factor into a repeated measures analysis of variance incorporating the main within subjects experimental factor. Again there was both no significant effect of encoding condition order ($F_{3,9}=0.48, p>.05$), and no interaction with the main experimental factor ($F_{9,27}=0.44, p>.05$). The full ANOVA table can be found in Appendix VII (Table 2). Therefore there were no effects of order of presentation of encoding conditions in the experiment.

Finally, diagnosis (two levels) was entered as a between subjects factor into a repeated measures analysis of variance (Appendix VII Table 3) incorporating the main within subjects experimental factor. Again there was no significant effect of diagnosis ($F_{1,11}=0.01, p>.05$) and no interaction between diagnosis and encoding condition ($F_{3,33}=0.80, p>.05$). There was no difference in performance on the four encoding condition phases between those diagnosed as suffering Alzheimer's Disease and those with Vascular dementia. This justifies pooling the data of all subjects regardless of diagnosis.

Main Experimental Manipulations. Figure 2 represents the group mean number of cues required to correctly retrieve the name following a one hour delay under each of the four experimental encoding conditions. With photo/name order, encoding condition order and diagnosis collapsed, a one-way repeated measures ANOVA revealed a significant main effect for encoding condition ($F_{3,36}=4.26, p<.05$). Post hoc comparison of means using the Newman Keuls procedure demonstrated that, as predicted, spaced retrieval was superior to massed retrieval, spaced reminding and massed reminding. Significantly fewer cues were required for subjects to recall the name after 60 minutes in the spaced retrieval condition than in any of the other three conditions. The full ANOVA table and post hoc comparisons are shown in Appendix VIII (Table 1 and Table 2).

Due to the conservative nature of the Newman Keuls test, it was decided to conduct a further one-way ANOVA on the latter three conditions in order to ensure their equivalence. There were no significant differences found between the three inferior encoding conditions ($F_{2,24} = 0.29, p > .05$). Results of this analysis can be found in Appendix VIII (Table 3). That is, spaced retrieval was superior to spaced reminding, massed retrieval and massed reminding, with these latter three conditions being performed equivalently.

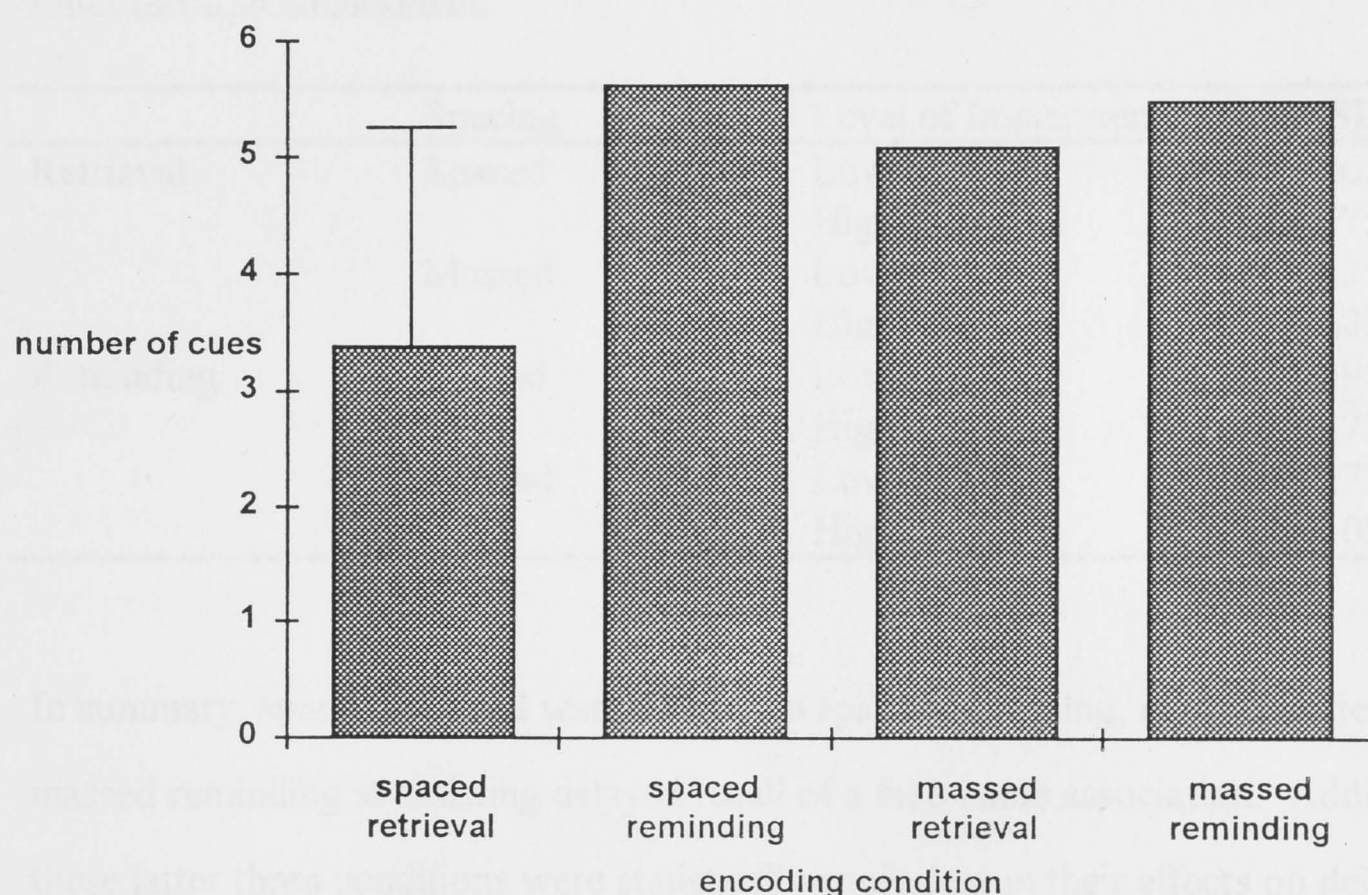


Figure 2. Mean number of cues required to correctly retrieve the name following training under each of the four experimental conditions

When level of impairment based on a median split of MMSE scores ($\geq 15, n = 7; < 15, n = 6$) was entered into the analysis as a between subjects factor with encoding condition (4), there was a significant main effect of encoding condition ($F_{3,33} = 4.39, p < .05$), but no main effect for level of impairment ($F_{1,11} = 0.10, p > .05$) nor an encoding condition by level of impairment interaction ($F_{3,33} = 1.29, p > .05$). That is, level of impairment had no effect on performance in the four experimental conditions

and consequently this variable was not studied further. Table 2 shows the group mean and standard deviation for number of cues required to correctly retrieve the name following training under each encoding condition for both levels of impairment (low versus high). The full ANOVA table is shown in Appendix VIII (Table 4).

Table 2.

Means and Standard Deviations For Number of Cues Required to Correctly Retrieve the Name Following Training Under Each of the Four Experimental Conditions For Each Level of Impairment.

	Spacing	Level of Impairment	Mean (SD)
Retrieval	Spaced	Low	3.43 (1.62)
		High	3.33 (1.75)
	Massed	Low	5.86 (1.35)
		High	4.17 (2.32)
Reminding	Spaced	Low	5.57 (1.90)
		High	5.67 (1.75)
	Massed	Low	5.00 (1.73)
		High	6.00 (2.00)

In summary, spaced retrieval was superior to spaced reminding, massed retrieval and massed reminding at assisting delayed recall of a face-name association. Additionally, these latter three conditions were statistically equivalent in their effects on delayed recall. This finding was not confounded by photo-name order effects nor encoding condition order effects, and it was consistent regardless of subjects' diagnosis or level of impairment.

Cognitive Effort Effects.

Response Times. Response times were only recorded during the two retrieval training sessions since during the reminding training sessions subjects were not required to retrieve information. The number of training trials administered during the spaced retrieval and massed retrieval conditions were individually tailored, making comparisons between individuals in time to respond on particular trials difficult. Accordingly, the decision was made to examine trends in time taken to recall the association across training trials by selecting three points during training: each subject's initial, middle and final training retrieval trial. Retrieval time on the middle trial was included to determine whether the trend in reaction times across training trials was linear. Raw data on these response times are presented in Appendix IX (Table 1).

Table 3 shows mean time taken during the two retrieval encoding conditions to recall the association at these three training session stages. Again, there appear to have been some potentially univariate outliers in the response time distributions and some non-normal distributions but the decision was made to retain all outliers and leave distributions untransformed.

Table 3.

Means and Standard Deviations For Time Taken to Correctly Retrieve the Name at the Initial, Middle and Final Training Session Stages of the Massed and Spaced Retrieval Encoding Conditions.

Retrieval Encoding Condition Type	Training Session Stage	Mean (SD) (seconds)
Spaced Retrieval	Initial	.91 (.38)
	Middle	2.03 (2.51)
	Final	3.33 (3.84)
Massed Retrieval	Initial	.98 (.33)
	Middle	.84 (.23)
	Final	.90 (.31)

A two way repeated measures ANOVA revealed a significant main effect for training session stage ($F_{2,24}=4.022$, $p<.05$), no significant main effect for retrieval encoding condition type ($F_{1,12}=4.15$, $p>.05$), and a significant interaction between retrieval encoding condition type and training session stage ($F_{2,24}=4.27$, $p<.05$). This interaction is illustrated in Figure 3. The full ANOVA table is shown in Appendix IX (Table 2).

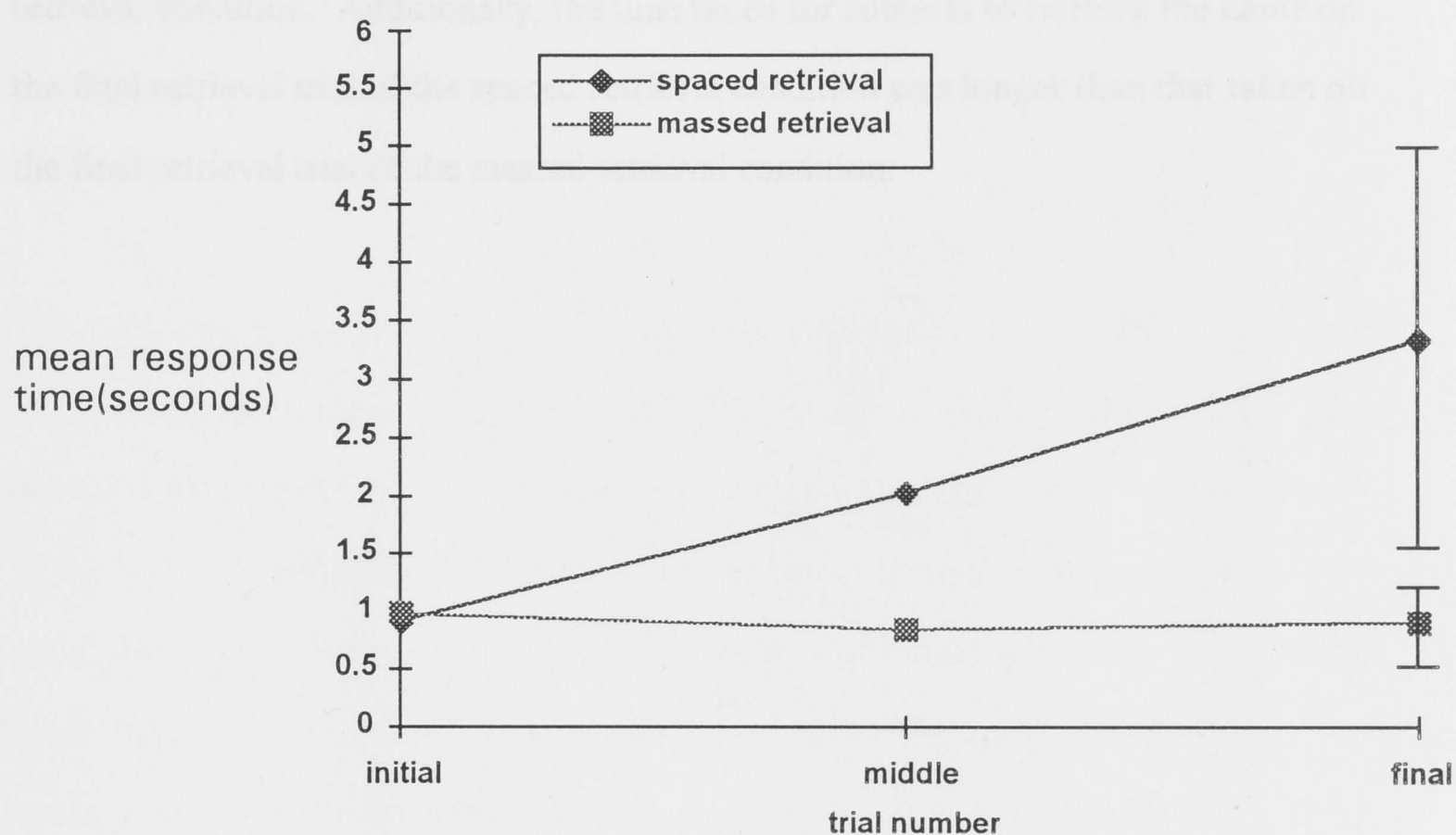


Figure 3. Comparison of mean response times across initial, middle and final trials of spaced retrieval and massed retrieval conditions.

A post-hoc one-way repeated measures ANOVA on each of the three training stages of the spaced retrieval condition revealed a significant effect ($F_{2,24} = 4.42$, $p<.05$). Examination of the means indicates that, as predicted, time taken to correctly recall the name increased as the length of time between retrieval trials increased. There was no such effect for the three training stages of the massed retrieval condition, ($F_{2,24} =$

1.08, $p > .05$). Full ANOVA tables can be found in Appendix IX (Tables 3 and 4 respectively).

The Effects of Spaced Retrieval

In summary, subjects required significantly more time to recall the name when presented with the face at the final (four minute interval) spaced retrieval training trial than they did on the initial learning trial. No such increase in response times was found between the initial and final retrieval trial training sessions in the massed retrieval condition. Additionally, the time taken for subjects to retrieve the name on the final retrieval trial of the spaced retrieval condition was longer than that taken on the final retrieval trial of the massed retrieval condition.

4.3 Discussion

The Efficacy of Spaced Retrieval:

The principal conclusion that can be drawn from this experiment is that delayed recall of a face-name association learned using spaced retrieval is superior to recall of associations learned using spaced reminding, massed retrieval and massed reminding. This is consistent with the predictions in section 3.4. The relatively superior performance at delayed recall in the spaced retrieval condition is positive evidence that spaced retrieval as a technique is able to assist acquisition of face-name associations in individuals with dementia.

Not only was spaced retrieval superior to the other three conditions, but it appears that training using these latter three conditions did not actually assist memory at all. On average, between five and six cues were required for correct recall of the names in these three conditions. Considering that the names were all between seven and eight letters long, providing between five and six cues limited the names that could be made from the cues and was usually sufficient to allow correct guessing. The average of three cues required in spaced retrieval were not sufficient to allow correct guessing. This is known because, it will be recalled, prior to each training session subjects were presented with an initial three letter stem; none could spontaneously produce the target name. It therefore appears justifiable to conclude that under spaced retrieval, the association had actually been learnt.

Before attempting to draw firm conclusions regarding the mnemonic efficacy of the technique, however, several findings warrant discussion and clarification. The first point to note is that although mean spaced retrieval was superior to the other three conditions, not every individual subject displayed this superiority. Nonetheless, given that some subjects were able to compensate for their deficit in memory, it seems

likely that some of the abilities necessary for successful completion of such a task are relatively intact in these individuals (Backman, 1989).

One may question whether any similarities exist within those who are able to benefit memorially from the technique. Within the present sample neither the level of impairment nor the diagnosis of the subjects was significantly related to performance in spaced retrieval. Furthermore, a correlation matrix constructed post-hoc between subjects' performance on the various tests in the neuropsychological battery and their delayed recall following spaced retrieval found no significant relationships. Thus no reliable prediction regarding the likely success of spaced retrieval training in any one individual could be made on the basis of their strengths in any particular cognitive domain sampled here. This correlation matrix can be found in Appendix X (Table 1). Other researchers investigating whether there are any individual difference measures that predict optimum benefit from spaced retrieval have also found that measures used to characterise level of functioning are not necessarily related to success in spaced retrieval (Camp & Schaller, 1989; McKittrick et al. 1992), although Bird & Kinsella (1996) did find that more impaired subjects required more assistance at final recall. At present, the factors that may predict which individuals will be most receptive to the memorial benefits afforded by spaced retrieval remain elusive. One can only conclude that when working with the brain impaired population, susceptibility to memory training will not be consistent across individuals (Backman, 1992), and that no one technique will work for all those with dementia.

The second point to note is that even in those who displayed superior recall performance with spaced retrieval training (that is, the majority), delayed recall was rarely spontaneous. An average of three cues were required for accurate delayed recall. This finding is hardly surprising given that the locus of action of spaced retrieval is at acquisition and that, as previously discussed, recall assistance is also required if any effect of manipulations at acquisition are to become apparent in those

with dementia (Bird & Luszcz, 1991; Diesfeldt, 1984). Providing cues serves only to decrease the need for controlled processing at recall as well as acquisition which, as discussed, is known to be impaired in this population. Thus the failure of subjects to spontaneously retrieve at delay does not imply spaced retrieval was not successful in teaching the association, but rather that this learnt information can still only be accessed with recall assistance.

Despite the fact that spaced retrieval does not provide memorial benefits for a certain percentage of individuals, and that training with spaced retrieval does not eliminate the need for assistance at recall, there is no question that it is an effective mnemonic technique for assisting acquisition in certain individuals with dementia. The development of memory improvement techniques will require us to determine the mechanisms responsible for producing memory performance (McEvoy, 1992). What are the active factors in spaced retrieval, and what is happening to the memory trace over time? It seems unlikely that any one single factor, process or theory will be able to adequately explain spaced retrieval. A multi-factorial explanation appears more plausible. However, the results attained here do add to the discussion.

The advantage of spaced retrieval over spaced reminding suggests that successful retrieval is affording more benefits than merely allowing a re-presentation of the information. The act of retrieving appears to play an active role in the efficacy of the technique. Nevertheless, the present results suggest that it is not retrieval alone that is responsible for the mnemonic effectiveness of spaced retrieval. If it were, the two retrieval conditions should have performed equivalently and, further, both of these retrieval conditions should have been superior to the two reminding conditions. This was not the case.

Similarly, the relative advantage of spaced retrieval over massed retrieval suggests that the spacing of retrieval trials is also an important component in the efficacy of

the technique. However, this spacing effect cannot be solely responsible for the superiority of spaced retrieval. If it were then the action on delayed recall of spacing the trials should be similar regardless of whether trials consisted of retrieval or reminding. This was clearly not the case. Instead it appears that it is the joint action of the active attempts at retrieval and the spacing that these retrieval trials are conducted on that are responsible for the efficacy of the technique. Given the active role that both retrieval and spacing play in spaced retrieval, it is necessary to determine how it is that these active retrieval trials conducted over expanding intervals of time are able to assist acquisition of information in those with dementia.

Whether a certain type of rehearsal will strengthen a memory trace depends on what the subject is doing with the rehearsal (Craig & Lockhart, 1971; Tulving, 1966). It seems that somehow rehearsals consisting of repeated retrievals of the information, and spacing these retrievals over expanding intervals of time, is allowing a more effective processing of the information.

The Role of Cognitive Effort:

As previously discussed, cognitive effort has been suggested as an important factor underlying the mnemonic effectiveness of both retrieval trials and the spacing effect independently, and of spaced retrieval as a technique. This hypothesis was specifically tested in the present experiment. It was predicted that if cognitive effort was contributing to the mnemonic effectiveness of spaced retrieval, the time taken to recall the name when the face was presented on each trial should increase as the inter-trial intervals in spaced retrieval increased. It was postulated that the greater the time between active retrieval attempts, the more difficult it is to retrieve the association and thus the greater the effort required for retrieval. Consistent with predictions, response time data showed an increase in recall time across retrieval trials in the spaced retrieval condition. No such trend was found in the massed retrieval condition. When intervals are uniform and massed, retrieval is relatively

easy and thus little cognitive effort is required for correct recall. As the inter-trial intervals are increased, retrieval becomes more difficult, and consequently greater cognitive effort is required for an accurate response. Given that delayed recall was superior in the spaced retrieval condition, one can conclude that this advantage arose as a result of the greater cognitive effort that was required during the learning phase of this condition. The present study thus provides direct experimental support for the role of cognitive effort in the efficacy of the spaced retrieval technique.

Given the importance of cognitive effort in the efficacy of spaced retrieval, it is unlikely that the process relies on implicit memory. Observation of the subjects' ability to eliminate errors in the present experiment adds support to this argument. It is well known that implicit learning is not widely used in rehabilitation, as it is poorly equipped to deal with errors where a specific item of clinical information must be learned (Baddeley, 1992a; Wilson, 1992b; Wilson, Baddeley, Evans & Shiel, 1994). Once an individual with memory problems makes an error, these errors become the habitual implicit response and are therefore not remembered as errors and are not eliminated (Wilson, 1992b). In the present study, mistakes made during spaced retrieval were able to be eliminated by the subjects and the correct response produced on following trials. This ability to learn from, and correct mistakes, is not consistent with an implicit memory process.

In light of the findings from the present study, it is necessary to re-examine the evidence that has been presented elsewhere that suggests spaced retrieval is in fact automatic and non-effortful. Several arguments can be raised against such a claim. First, the fact that recall in spaced retrieval in this study was susceptible at all to manipulations of effort (by increasing the inter-trial intervals) suggests that it is unlikely to be an automatic process. If a process is automatic, its efficacy should depend only on how intact the memory is, and be independent of such manipulations (Grafman et al. 1990; Kahneman 1973, as cited in Grafman et al. 1990).

Secondly, a large majority of the claims that spaced retrieval is automatic have been based on the assumption that implicit memory processes remain intact in those with dementia, and it is this implicit memory that is tapped with spaced retrieval.

However, as previously discussed, the fate of implicit memory functioning in those with dementia is actually still an area of contention. Furthermore, the existence of well documented deficits in explicit memory in dementia, usually secondary to damage to the hippocampus and related brain structures, does not preclude the possibility that spaced retrieval is somehow tapping into explicit memory processes. It is plausible that spaced retrieval may be either making these damaged neural structures function when they ordinarily wouldn't, or it is somehow tapping into other neural structures and circuits that are involved in explicit memory but are not dependent upon the hippocampus.

Finally, the two major pieces of evidence offered that appear to show spaced retrieval is an implicit memory process are capable of an alternative interpretation. The main evidence that Camp and colleagues offer for spaced retrieval being implicit is their observation of their subject's behaviour during recall. They claim that because their subjects were unable to state where the recalled information came from, that they were not confident in the accuracy of their responses, and that they profess to have known the correct answer upon hearing it even if they did not produce it, that the information must have been learned implicitly.

There may be some confusion here between implicit memory, and problems experienced by those with dementia in the ability to explicitly encode and recall information. Suppose an individual with dementia is required to learn the name of a staff member using spaced retrieval training (for example Camp & Schaller, 1989). During this training, the only piece of information learned is the association between the staff members face and their name. As information pertaining to the source of the

information is not encoded with the association, it is unlikely that the person will be able to remember it, unless assisted by the experimenter to acquire and recall it. That is, the fact that s/he cannot state the source of the information may merely reflect the fact that it had not been taught, rather than the fact that the information regarding the name must have been learned implicitly.

In addition, the lack of confidence in responding and the subjects' claim to have known the right answer even when this is not produced could be attributed, in part, to the fact that no recall assistance is actually given on each retrieval trial during spaced retrieval training. As previously discussed, those with dementia require recall assistance if learnt information is to be recalled. One can speculate that, had recall assistance been given during spaced retrieval trials in the studies done by Camp, the subjects would have been both more accurate and more confident in the accuracy of their responses. Rather than suggesting that the information was learnt implicitly, these behaviours of the subjects may actually reflect a need for assistance in retrieving information that has been explicitly acquired.

The only experimental study to date that has examined the role of implicit memory in spaced retrieval in those with dementia concluded that spaced retrieval engages an implicit encoding and memory system (Foss & Camp, in press). This conclusion was based on the finding that subjects' ability to recall a face-name association on each trial during spaced retrieval training was unaffected by the amount of cognitive effort required for a secondary task performed between these training trials and prior to delayed recall (Foss & Camp, in press).

In the Foss and Camp study (in press), manipulating the subject's available cognitive resources between retrieval trials had no apparent effect on their ability to retrieve the information on each trial, as determined by the accuracy of their responses. This may suggest that the learning or consolidation that is taking place between retrieval trials

may not rely on cognitive effort. However, concluding from this that spaced retrieval engages implicit memory processes relies on the assumption that the locus of learning during spaced retrieval training is between retrieval trials. That is, the assumption must be made that when a subject is learning a piece of information using spaced retrieval, the learning of the information is actually taking place between trials (e.g. consolidation), and consequently that manipulating the cognitive effort they have available for processing during this time will have a detrimental effect on accuracy of retrieval.

Other studies, not using subjects with dementia, have employed a similar paradigm to Foss and Camp but have found that long term retention is actually improved when a difficult task is interpolated between repetitions of the to-be-remembered item (Bjork & Allen, 1970; Tzeng, 1973). This suggests first that during spaced retrieval training, recall is susceptible to manipulations of cognitive effort, and second, that the locus of action of learning, and consequently the locus of action of cognitive effort cannot be during the inter-trial interval. If learning is occurring between trials and cognitive effort is being utilised during the inter-trial interval to try and consolidate the information from the previous trial, interpolating a cognitively demanding task at this stage should have detrimental effects on delayed recall. This clearly is not the case.

It appears instead that learning is actually taking place at the point of retrieval; cognitive effort is being utilised on the second retrieval trial in order to access the information that has been almost forgotten since the previous trial. The locus of action of cognitive effort in spaced retrieval appears to be at the active attempts at retrieval, rather than at consolidation between trials. This was confirmed by the results obtained in the present study: latencies between presentation of the picture and the response increased as a function of the difficulty of the act of retrieval. The failure to find any effect of manipulations of cognitive effort on retrieval in the Foss

and Camp (in press) study appears to be due to the fact that no direct measurement was taken of the cognitive effort required to retrieve the information on each trial during spaced retrieval.

Fate of the Memory Trace:

It seems that the more difficult the act of retrieval is during training, the better delayed recall. Prior to training in this study, the subjects had memory spans of no more than 30 seconds. By the end of spaced retrieval training they were able to remember the association for 240 seconds. Evidently, their memory trace must have strengthened over trials. Somehow, the "forgetting" between retrieval trials that seems to be necessary for maximum benefits to be obtained from subsequent trials allowed this memory trace to build up. How can one reconcile that at the same time an individual appears to be forgetting information, their memory trace for that information is actually strengthening?

Bjork & Bjork (1992) suggest that the retrievability of an item depends both on how well it is learned (storage strength), and how easy it is to access that information (retrieval strength). The largest increase in the retrievability of information as a consequence of recalling that information will take place for information that is high in storage strength but also low in retrieval strength. At short delays, an item will be not well learned but relatively easy to retrieve. As the inter-trial interval is increased, an items storage strength increases, but the information is more difficult to retrieve. In spaced retrieval then, the "forgetting" that appears to occur during the inter-trial intervals may be reflecting the information's low retrieval strength. However, this item may actually be well stored and it is this storage strength that is being built up over time and enabling the information to be recalled following a delay.

The Role of Encoding Specificity in Spaced Retrieval:

It will be recalled that in addition to cognitive effort, encoding specificity is another method of ensuring adequate processing of information in order to assist memory (Jacoby & Craik, 1979). If a cue associated with the to-be-remembered information during acquisition is reinstated at retrieval, it will be a more powerful retrieval prompt than cues not originally encoded (Tulving & Thomson, 1973).

In the present study, the same retrieval cue (photograph) was presented to subjects during training as was presented to them one hour after training in order to assist their delayed recall. Undoubtedly, this encoding specificity would have made the delayed recall of the information stored during training easier, and conveys further advantages to the spaced retrieval technique.

Clinical Application:

Evidently, the effect of spaced retrieval is not to restore memory functioning in those with dementia, but realistically to try to provide optimum conditions for learning specific knowledge which will help patients in their everyday functioning. It is unlikely that practice using spaced retrieval will improve memory for any materials other than those specifically taught during training, or that this training will generalise to other contexts (this is not a specific problem with spaced retrieval - memory improvement strategies for subjects with brain impairment are, in general, situation specific and will not generalise, Glisky & Schacter, 1987; Moffat, 1992; Zacks & Hasher, 1992). However, the fact that little evidence exists to suggest that memory restoration can result from any memorial treatments so far devised should not deter us from rehabilitating patients to their optimum levels of achievement (Wilson, 1992b).

It is obvious from the results of this, and other such studies, that there is the potential to help reduce the problems faced by those with dementia and their families, despite

the fact that dementia is a progressive and irreversible disorder (Wilson & Poon, 1989). Anything that will help circumvent the cognitive limitations of individuals with dementia will obviously result in an improvement in the quality of life of both patients and their carers/families (Camp, 1989; Glisky & Schacter, 1987; Tuokko, Vernon-Wilkinson, Weir & Beattie, 1991). Such improvements may take the form of prolonging their independent functioning (McKittrick et al. 1992), assisting in their psychosocial adjustment (Moffat 1986, as cited in Moffat, 1989), or even in giving the individual a sense of pride (Camp & Schaller, 1989).

To date, spaced retrieval has been used to teach Alzheimer's patients face-name associations, names of objects, object-location associations, cue-task associations, prospective memory tasks, and a strategy for using external memory aids. Individuals have been taught such important information as the names of their family members and carers, relevant personal history, the location of various important objects, and how to use a diary. The clinical significance of teaching such information is obvious. Spaced retrieval has also been adapted for dealing with some of the behaviour problems that many individuals with dementia suffer. Examples of this that have been tried include: eliminating the repetitive asking of a question by teaching the individual to go and consult a notice, eliminating intrusive behaviour which often led to aggression by teaching the association between a STOP sign and not entering others' rooms, and preventing multiple and unnecessary visits to the toilet by teaching the association between a beeper and a toilet visit (Bird, Alexopoulos & Adamowicz, 1995). In each of these cases, the problem behaviour was greatly reduced or ceased. Evidently, spaced retrieval holds great potential for use as a clinical intervention.

Aside from the important fact that it can help some individuals learn certain pieces of information, spaced retrieval also has other advantages as a mnemonic technique: the technique is non-threatening as it is implemented in the context of a social visit during

day to day activities (Camp, 1989); it prevents test anxiety in the subjects as it has a high frequency of success (Camp & McKittrick, 1992); and it requires low level technology (Camp et al. in press). Further, the fact that the nature of the task constrains the type of processing which can be conducted on the to-be-remembered information ensures that maximum benefit can always be achieved from training, and it can have a positive effect on caregivers as well as on the patients themselves (Camp et al. in press).

Recently, the spaced retrieval technique has been computerised (Camp & Schaller, 1989) which allows greater experimenter control over training and also makes the technique easier to administer. Furthermore, it has been shown that caregivers are able to learn to implement spaced retrieval effectively with only minimal training (McKittrick 1993, as cited in Camp et al. in press; Riley, 1992). This means that the technique can be made available to a wider collection of individuals and that carers can play a role in helping ameliorate some of the memory and behaviour problems suffered by those with dementia.

As the use of spaced retrieval as a mnemonic technique is still in its infancy, there remain several unknowns. First, it is unknown how much information an individual with dementia is able to learn and retain using spaced retrieval (Camp, 1989).

Second, it still remains to be determined how long information learned using spaced retrieval is maintained (Camp, 1989). Third, some individuals may require large amounts of training before the information is learned and as shown in the present study, some individuals will not benefit from the training.

Camp (1989) has also raised additional unanswered questions regarding spaced retrieval. What skills are needed for information to be retained? Are there limitations to the type of information that can be taught? What is the best way to teach and subsequently retain more than one piece of information? What is the best interval

schedule for retrieval trials to be conducted on? Future studies in this area need to address experimentally and clinically the answers to these questions and the answers to the above unknowns.

Conclusions:

The present study confirms that there is potential for memory improvement in dementia. Spaced retrieval is a technique that is able to assist acquisition of discrete pieces of information in those with dementia. Although it is not possible at this stage to offer a firm explanation of how spaced retrieval actually assists acquisition of information in those with dementia, several conclusions can be drawn from the present results. It has been shown that both active successful attempts at retrieving the information, and appropriate spacing of these attempts, are necessary for the mnemonic success of the technique. The results also imply that cognitive effort is responsible for the efficacy of the technique.

If we are to ensure that those with dementia live the highest quality of life, there is an urgent need for more research and development of methods that can improve their memory functioning (Backman et al. 1991; Pressley & Beard El-Dinary, 1992). It is unlikely that any single solution will be found to help all people with memory difficulties nor can we expect one strategy or technique to solve all the memory problems experienced by an individual patient (Wilson, 1992a). Spaced retrieval is one tool that is available to the clinician for attempting to assist memory in those with dementia.

REFERENCES

- Alatuzoff, I. (1992). The pathology of dementias: An overview. Acta Neurologica Scandinavica, 85(139), 8-15.
- Amaducci, L., Falcini, M., & Lippi, A. (1992). Descriptive epidemiology and risk factors for Alzheimer's Disease. Acta Neurologica Scandinavica, 85(139), 21-25.
- American Psychiatric Association. (1994). Diagnostic and statistical manual of mental disorders (4th ed.). Washington, DC: Author.
- Anonymous. (1981). Organic mental impairment of the elderly. Journal of the Royal College of Physicians of London, 15, 185-189.
- Appell, J., Kertesz, A., & Fisman, M. (1982). A study of language functioning in Alzheimer patients. Brain and Language, 17, 73-91.
- Backman, L. (1989). Varieties of memory compensation by older adults in episodic remembering. In L.W. Poon, D.C. Rubin & B.A. Wilson (Eds.), Everyday cognition in adulthood and late life (pp. 509-544). New York: Cambridge University Press.
- Backman, L. (1990). Plasticity of memory functioning in normal aging and Alzheimer's Disease. Acta Neurologica Scandinavica, 82(Suppl.129), 32-36.
- Backman, L. (1992). Memory training and memory improvement in Alzheimer's disease: Rules and exceptions. Acta Neurologica Scandinavica, Suppl 139, 84-89.

Backman, L., Josephsson, S., Herlitz, A., Stigsdotter, A., & Viitanen, M. (1991).

The generalisability of training gains in dementia: Effects of an imagery-based mnemonic on face-name retention duration. Psychology and Aging, 6(3), 489-492.

Baddeley, A.D. (1992). Implicit memory and errorless learning: A link between

cognitive theory and neuropsychological rehabilitation? In L.R. Squire & N. Butters (Eds.), Neuropsychology of Memory (2nd ed.) (pp. 309-314). New York: The Guilford Press.

Baddeley, A., Logie, R., Bress, S., Della Sala, S., & Spinnler, H. (1986). Dementia

and working memory. Quarterly Journal of Experimental Psychology, 38(A), 603-618.

Becker, J.T., Bajulaiye, O., & Smith, C. (1992). Longitudinal analysis of a two-component model of the memory deficit in Alzheimer's Disease.

Psychological Medicine, 22, 437-445.

Berg, R.A., Franzen, M., & Wedding, D. (1994). Screening for brain impairment: A manual for mental health practice. New York: Springer Publishing Company.

Bird, M.J., Alexopoulos, P., & Adamowicz, J. (1995). Success and failure in five

case studies: Use of cued recall to ameliorate behaviour problems in senile dementia. International Journal of Geriatric Psychiatry, 10, 305-311.

Bird, M.J., & Kinsella, G. (1996). Long-term cued recall of tasks in senile dementia.

Psychology and Aging, 11(1), 45-56.

- Bird, M.J., & Luszcz, M.A. (1991). Encoding specificity, depth of processing, and cued recall in Alzheimer's disease. Journal of Clinical and Experimental Neuropsychology, 13, 508-520.
- Bird, M., & Luszcz, M. (1993). Enhancing memory performance in Alzheimer's Disease: Acquisition assistance and cue effectiveness. Journal of Clinical and Experimental Neuropsychology, 15(6), 921-932.
- Bjork, R.A. (1988). Retrieval practice and the maintenance of knowledge. In M.M. Gruneberg, P.E. Morris., & R.N. Sykes (Eds.), Practical aspects of memory: Current research and issues: Vol 1. Memory in everyday life (pp. 396-401). Chichester: Wiley.
- Bjork, R.A., & Allen, T.W. (1970). The spacing effect: Consolidation or differential encoding? Journal of Verbal Learning and Verbal Behaviour, 9, 567-572.
- Bjork, R.A., & Bjork, E.L. (1992). A new theory of disuse and old theory of stimulus fluctuation. In A.F. Healy, S.M. Kosslyn, & R.M. Shiffrin (Eds.), From learning processes to cognitive processes: Essays in honour of William K. Estes. Vol 2 (pp. 35-67). New Jersey: Erlbaum.
- Black, F.W., & Strub, R.L. (1994). The bedside and office mental status examination. In S.Touyz, D. Byrne, & A. Gilandas (Eds.), Neuropsychology in Clinical Practice (pp. 38-60). Sydney: Academic Press, Inc.
- Bondi, M.W., & Kaszniak, A.W. (1991). Implicit and explicit memory in Alzheimers Disease and Parkinsons Disease. Journal of Clinical and Experimental Neuropsychology, 13, 339-358.

- Buschke, H. (1984). Cued recall in amnesia. Journal of Clinical Neuropsychology, 6, 441-453.
- Butters, N., Granholm, E., Salmon, D.P., Grant, I., & Wolfe, J. (1987). Episodic and semantic memory: A comparison of amnesic and demented patients. Journal of Clinical and Experimental Neuropsychology, 9, 479-497.
- Butters, N., Heindel, W.C., & Salmon, D. (1990). Dissociation of implicit memory in dementia: Neurological implications. Bulletin of the Psychonomic Society, 28, 359-366.
- Buyer, L.S., & Dominowski, R.L. (1989). Retention of solutions: It is better to give than receive. American Journal of Psychology, 102, 353-363.
- Camp, C.J. (1989). Facilitation of new learning in Alzheimer's disease. In G.C. Gilmore, P.J. Whitehouse, and M.L. Wykel (Eds.), Memory, aging, and dementia: Theory, assessment, and treatment (pp. 212-225). New York: Springer.
- Camp, C.J., Foss, J.W., O'Hanlon, A.M., & Stevens, A.B. (in press). Memory interventions for persons with dementia.
- Camp, C.J., & McKittrick, L. (1992). Memory interventions in Alzheimer's-type dementia populations: Methodological and theoretical issues. In R.L. West & J.D. Sinnott (Eds.), Everyday memory and aging: Current research methodology (pp. 155-172). New York: Springer.
- Camp, C.J., & Schaller, J.R. (1989). Epilogue: Spaced-retrieval memory training in an adult day-care centre. Educational Gerontology, 15, 641-648.

- Camp, C.J., & Stevens, A.B. (1990). Spaced-retrieval: A memory intervention for dementia of the Alzheimer's-Type (DAT). Clinical Gerontologist, 10, 58-61.
- Christensen, H., Hadzi-Pavlovic, D., & Jacomb, P. (1991). The psychometric differentiation of dementia from normal aging: A meta-analysis. Psychological Assessment: A Journal of Consulting and Clinical Psychology, 3(2), 147-155.
- Christensen, H., Maltby, N., Jorm, A.F., Creasey, H., & Broe, G.A. (1992). Cholinergic 'blockage' as a model of the cognitive deficits in Alzheimer's Disease. Brain, 115, 1681-1699.
- Coyle, J.T., Price, D.L., & DeLong, M.R. (1983). Alzheimer's disease: A disorder of cortical cholinergic innervation. Science, 219, 1184-1190.
- Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behaviour, 11, 671-684.
- Cuddy, L.J., & Jacoby, L.L. (1982). When forgetting helps memory: An analysis of repetition effects. Journal of Verbal Learning and Verbal Behaviour, 21, 451-467.
- Davis, P.E., & Mumford, S.J. (1984). Cued recall and the nature of the memory disorder in dementia. British Journal of Psychiatry, 144, 383-386.
- Dellarosa, D., & Bourne, L.E. (1985). Surface form and the spacing effect. Memory and Cognition, 13(6), 529-537.

- Dempster, F.N. (1988). The spacing effect: A case study in the failure to apply the results of psychological research. American Psychologist, 43(8), 627-634.
- Dick, M.B., Kean, M-L., & Sands, D. (1989). Memory for action events in Alzheimer-type dementia: Further evidence of an encoding failure. Brain & Cognition, 9, 71-87.
- Diesfeldt, H.F. (1984). The importance of encoding instructions and retrieval cues in the assessment of memory in senile dementia. Archives of Gerontology and Geriatrics, 3, 51-57.
- Downes, J.T., Davis, E.J., DeMornay Davies, P., Perfect, T.J., Wilson, K., Mayes, A.R., & Sagar, H.J. (1996). Stem-completion priming in Alzheimers Disease: The importance of target word articulation. Neuropsychologia, 34(1), 63-75.
- Edwards, A.J. (1994). When memory fails: Helping the Alzheimer's and dementia patient. New York: Plenum Press.
- Emery, V.O.B., Gillie, E.X., & Ramdev, P.T. (1996). Noninfarct vascular dementia: A new subtype. Journal of Clinical Geropsychology, 2(3), 197-213.
- Emery, V.O.B., Gillie, E.X., & Smith, J.A. (1996). Reclassification of the vascular dementias: Comparisons of infarct and non-infarct vascular dementias. International Psychogeriatrics, 8(1), 33-61.
- Epstein, M.L., Phillips, W.D., & Johnson, S.J. (1975). Recall of related and unrelated word pairs as a function of processing level. Journal of Experimental Psychology: Human Learning and Memory, 104(2), 149-152.

- Feinberg, T., & Goodman, B. (1984). Affective illness, dementia, and pseudodementia. Journal of Clinical Psychiatry, 45, 100-103.
- Ferris, S.H. (1990). Therapeutic strategies in dementia disorders. Acta Neurologica Scandinavica, 82(suppl 129), 23-26.
- Ferris, S.H. (1992). Diagnosis by specialists: Psychological testing. Acta Neurologica Scandinavica, 85(139), 32-35.
- Fischer, P., Gatterer, G., Marterer, A., Simanyi, M., Danielczyk, W., & Course, W. (1991). Course characteristics in the differentiation of dementia of the Alzheimer's type and multi-infarct dementia. Acta Psychiatrica Scandinavica, 81, 551-553.
- Flicker, C., Bartus, R.T., Crook, T.H., & Ferris, S.H. (1984). Effects of aging and dementia upon recent visuo-spatial memory. Neurobiology of Aging, 5, 275-283.
- Folstein, M.F., Anthony, J.C., Parhad, I., Duffy, B., & Gruneberg, E.M. (1985). The meaning of cognitive impairment in the elderly. Journal of the American Geriatrics Society, 33, 228-235.
- Folstein, M.F., Folstein, S.E., & McHugh, P.R. (1975). 'Mini-Mental State': A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12, 189-198.
- Foos, P.W., & Smith, K.H. (1974). Effects of spacing and spacing patterns in free recall. Journal of Experimental Psychology: General, 103(1), 112-116.

- Foss, J.W., & Camp, C.J. (in press). Effortless face-name learning in Alzheimer's Disease using spaced-retrieval training in a dual-talk paradigm. Neuropsychology.
- Fox, J.H., Kaszniak, A.W., & Huckman, M.S. (1979). Computerised tomographic scanning not very helpful in dementia. New England Journal of Medicine, 300, 437.
- Friedland, R.P., Budinger, T.F., Brant-Zawadzki, M., & Jagust, W.J. (1984). The diagnosis of Alzheimer-type dementia. Journal of the American Medical Association, 252, 2750-2752.
- Fuld, P.A. (1980). Guaranteed stimulus processing in the evaluation of memory and learning. Cortex, 16, 255-271.
- Fuld, P.A., Masur, D.M., Blau, A.D., Crystal, H., & Aronson, M.K. (1990). Object-memory evaluation for prospective detection of dementia in normal functioning elderly: Predictive and normative data. Journal of Clinical and Experimental Psychology, 12, 520-528.
- Gardner, J.M., Craik, F.I.M., & Bleasdale, F.A. (1973). Retrieval difficulty and subsequent recall. Memory and Cognition, 1, 213-216.
- Gartman, L.M., & Johnson, N.F. (1972). Massed versus distributed repetition of homographs: A test of the differential-encoding hypothesis. Journal of Verbal Learning and Verbal Behaviour, 11, 801-808.

- Glanzer, M. (1969). Distance between related words in free recall: Trace of the STS. Journal of Verbal Learning and Verbal Behaviour, 8, 105-111.
- Glenberg, A.M. (1979). Component-levels theory of the effects of spacing of repetition on recall and recognition. Memory and Cognition, 7(2), 95-112.
- Glisky, E.L., & Schacter, D.L. (1987). Acquisition of domain specific knowledge in organic amnesia: Training for computer-related work. Neuropsychologia, 25, 893-906.
- Glisky, E.L., Schacter, D.L., & Tulving, E. (1986). Learning and retention of computer-related vocabulary in memory-impaired patients: Method of vanishing cues. Journal of Clinical and Experimental Neuropsychology, 8, 292-312.
- Go, R.C.P., Todorov, A.B., Elston, R.C., & Constantinidis, J. (1978). The malignancy of dementias. Annals of Neurology, 3, 559-561.
- Golden, C.J. (1990). Clinical interpretation of objective psychological tests. Massachusetts: Allyn & Bacon.
- Goodglass, H., & Kaplan, E. (1984). The Boston Diagnostic Aphasia Examination. Philadelphia: Lea & Febinger.
- Gotz, A., & Jacoby, L.L. (1974). Encoding and retrieval processes in long-term retention. Journal of Experimental Psychology, 102, 291-297.

- Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. Journal of Verbal Learning and Verbal Behaviour, 23, 553-568.
- Grafman, J., & Matthews, C.G. (1978). Assessment and remediation of memory deficits in brain-injured patients. In M.M. Gruneberg, P.E. Morris & R.N. Sykes (Eds.), Practical aspects of memory (pp. 720-732). New York: Academic Press.
- Grafman, J., Weingartner, H., Lawlor, B., Mellow, A.M., Thompsen-Putnam, K., & Sunderland, T. (1990). Automatic memory processes in patients with dementia-Alzheimer's type (DAT). Cortex, 26, 361-371.
- Granholm, E., & Butters, N. (1988). Associative encoding and retrieval in Alzheimer's and Huntingdon's disease. Brain and Behaviour, 7, 335-347.
- Hagman, J.D. (1983). Presentation and test trial effects on acquisition and retention of distance and location. Journal of Experimental Psychology: Learning, Memory and Cognition, 9, 334-345.
- Hanley, E.G. (1981). The use of signposts and active training to modify ward disorientation in elderly patients. Journal of Behaviour Therapy and Experimental Psychiatry, 12(3), 241-247.
- Hanley, E. (1986). Reality orientation in the care of the elderly patient with dementia: Three case studies. In I. Hanley & M. Gilhooly (Eds.), Psychological therapies for the elderly (pp. 65-79). London: Croom Helm.

- Hanley, E.G., McGuire, R., & Boyd, W.D. (1981). Reality orientation and dementia: A controlled trial of two approaches. British Journal of Psychiatry, 138, 10-14.
- Harris, J.E. (1992). Ways to help memory. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of Memory Problems (pp. 59-85). Melbourne: Chapman & Hall.
- Hart, R.P., & O'Shanick, G.J. (1993). Forgetting rates for verbal, pictorial, and figural stimuli. Journal of Clinical and Experimental Neuropsychology, 15(2), 245-265.
- Hart, S., & Semple, J.M. (1990). Neuropsychology and the dementias. New York: Taylor and Francis.
- Hart, S.A., Smith, C.M., & Swash, M. (1988). Word fluency in Alzheimer-type dementia. British Journal of Clinical Psychology, 27, 115-123.
- Hasher, L., & Zacks, R.T. (1979). Automatic and effortful processes in memory. Journal of Experimental Psychology: General, 108(3), 356-388.
- Heindel, W.C., Salmon, D.P., Shults, C.W., Walicke, P.A., & Butters, N. (1989). Neuropsychological evidence for multiple implicit memory systems: A comparison of Alzheimers, Huntingdons and Parkinsons Disease patients. Journal of Neuroscience, 9, 582-587.

- Herlitz, A., Adolfsson, R., Backman, L., & Nilsson, L-G. (1991). Cue utilisation following different forms of encoding in mildly, moderately and severely demented patients with Alzheimer's Disease. Brain and Cognition, 15, 119-130.
- Hersch, E.L., Kral, V.A., & Palmer, R.B. (1978). Clinical value of the London Psychogeriatric rating scale. Journal of the American Geriatrics Society, 26, 348-356.
- Hintzman, D.L. (1974). Theoretical implications of the spacing effect. In R.L. Solso (Ed.), Theories in cognitive psychology: The Loyola symposium (pp. 77-99). Maryland: Lawrence Erlbaum Associates.
- Hintzman, D.L., & Block, R.A. (1970). Memory judgements and the effects of spacing. Journal of Verbal Learning and Verbal Behaviour, 9, 561-566.
- Hodges, J.R., Salmon, D.P., & Butters, N. (1992). Semantic memory impairment in Alzheimer's disease: Failure of access or degraded knowledge? Neuropsychologia, 30(4), 301-314.
- Hogan, R.M., & Kintsch, W. (1971). Differential effects of study and test trials on long-term recognition and recall. Journal of Verbal Learning and Verbal Behaviour, 10, 562-567.
- Intons-Peterson, M.J., & Newsome, G.L. (1992). External memory aids: Effects and effectiveness. In D.J. Herrmann, H. Weingartner, A. Searleman & C. McEvoy (Eds.), Memory Improvement: Implications for Memory Theory (pp. 101-121). Springer-Verlag.

- Izawa, C. (1992). Test trials contributions to the optimisation of learning processes: Study/test trials interactions. In A.F. Healy, S.M. Kosslyn, & R.M. Shiffrin (Eds.), From learning processes to cognitive processes: Essays in honour of William K. Estes. Vol. 2 (pp. 1-31). New Jersey: Erlbaum.
- Jacoby, L.L., & Craik, F.I.M. (1979). Processing at encoding and retrieval: Trace distinctiveness and recovery of initial context. In L.S. Cermak and F.I.M. Craik (Eds.), Levels of processing in human memory (pp. 1-21). New Jersey: Erlbaum.
- Johnston, W.A., & Uhl, C.N. (1976). The contributions of encoding effort and variability to the spacing effect on free recall. Journal of Experimental Psychology: Human Learning and Memory, 2(2), 153-160.
- Jorm, A.F. (1986). Controlled and automatic processing in senile dementia: A review. Psychological Medicine, 16, 77-88.
- Jorm, A.F., & Henderson, A.S. (1993). The problem of dementia in Australia (3rd Edition). Canberra: Australian Government Publishing.
- Jorm, A.F., Korten, A.E., & Henderson, A.S. (1987). The prevalence of dementia: A quantitative integration of the literature. Acta Psychiatrica Scandinavica, 76, 465-479.
- Jorm, A., & MacKinnon, A. (1994). Psychogeriatric Assessment Scales User's Guide and Materials. Canberra: ANUTECH, Pty, Ltd.

- Jorm, A.F., MacKinnon, A.J., Henderson, A.S., Scott, R., Christensen, H., Korten, A.E., Cullen, J.S., & Mulligan, R. (in press). The Psychogeriatric Assessment Scales: A multi-dimensional alternative to categorical diagnoses of dementia and depression in the elderly. Psychological Medicine.
- Karlsson, T., Backman, L., Herlitz, A., Nilsson, L., Winblad, B., & Osterlind, P. (1989). Memory improvement in different stages of Alzheimer's Disease. Neuropsychologia, 27(5), 737-742.
- Kaszniak, A.W. (1986). The neuropsychology of dementia. In I. Grant & K.M. Adams (Eds.), Neuropsychological assessment of neuropsychiatric disorders (pp. 172-220). New York: Oxford University Press.
- Kay, D.W.K., Henderson, A.S., Scott, R., Wilson, J., Rickwood, D., & Grayson, D.A. (1985). Dementia and depression among the elderly living in the Hobart community: The effects of the diagnostic criteria on the prevalence rates. Psychological Medicine, 15, 771-778.
- Kazdin, A.E. (1984). Behaviour modification in applied settings. Chicago: Dorsey.
- Khachaturian, K.S. (1985). Progress of research on Alzheimer's Disease: Research opportunities for behavioural scientists. American Psychologist, 40, 1251-1255.
- Kopelman, M.D. (1985). Rates of forgetting in Alzheimer-type Dementia and Korsakoff's syndrome. Neuropsychologia, 23, 623-628.
- Kopelman, M.D. (1986a). Clinical tests of memory. British Journal of Psychiatry, 148, 517-525.

Kopelman, M.D. (1986b). Recall of anomalous sentences in dementia and amnesia.

Language, 29, 154-170.

Kopelman, M.D. (1986c). The cholinergic neurotransmitter system in human memory and dementia: A review. Quarterly Journal of Experimental Psychology, 38(A), 535-573.

Kopelman, M.D. (1991). Non-verbal, short-term forgetting in the alcoholic Korsakoff syndrome and Alzheimer-type dementia. Neuropsychologia, 29(8), 737-747.

Kopelman, M.D. (1992). The psychopharmacology of human memory disorders. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of Memory Problems (pp. 189-215). Melbourne: Chapman & Hall.

Kukull, W.A., Larson, E.B., Reifler, B.V., Lampe, T.H., Yerby, M., & Hughes, J. (1990a). The validity of 3 clinical diagnostic criteria for Alzheimer's Disease. Neurology, 40, 1364-1369.

Kukull, W.A., Larson, E.B., Reifler, B.V., Lampe, T.H., Yerby, M., & Hughes, J. (1990b). Interrater reliability of Alzheimer's Disease diagnosis. Neurology, 40, 257-290.

Landauer, T.K. (1969). Reinforcement as consolidation. Psychological Review, 76(1), 82-96.

- Landauer, T.K., & Bjork, R.A. (1978). Optimum rehearsal patterns and name learning. In M.M. Gruneberg, P. Morris, & R. Sykes (Eds.), Practical aspects of memory (pp 625-632). London: Academic.
- Lezak, M.D. (1976). Neuropsychological assessment. New York: Oxford University Press.
- Lezak (1983). Neuropsychological Assessment. (2nd Ed.). New York: Oxford University Press.
- Libon, D.J. (1993). Clock drawing as an assessment tool for dementia. Archives of Clinical Neuropsychology, 8, 405-415.
- Little, A.G., Volans, P.J., Hemsley, D.R., & Levy, R. (1986). The retention of new information in senile dementia. British Journal of Clinical Psychology, 25, 71-72.
- Margolin, D.I., Pate, D.S., & Friedrich, F.J. (1996). Lexical priming by pictures and words in normal aging and in dementia of the Alzheimers type. Brain and Language, 54, 275-301.
- Martin, A., Brouwers, P., Cox, C., & Fedio, P. (1985). On the nature of the verbal memory deficit in Alzheimer's Disease. Brain & Language, 25, 323-341.
- Martin, A., & Fedio, P. (1983). Word production and comprehension in Alzheimer's disease: The breakdown of semantic knowledge. Brain & Language, 19, 124-141.

- McEvoy, C.L. (1992). Memory improvement in context: Implications for the development of memory improvement theory. In D.J. Herrmann, H. Weingartner, A. Searleman, & C. McEvoy (Eds.), Memory improvement: Implications for memory improvement theory (pp. 210-231). New York: Springer-Verlag.
- McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E.M. (1984). Clinical diagnosis of Alzheimer's Disease: Report of the NINCDS-ADRDA work group under the auspices of the Department of Health and Human Services task force on Alzheimer's Disease. Neurology, 34, 939-944.
- McKittrick, L.A., Camp, C.J., & Black, F.W. (1992). Prospective memory intervention in Alzheimer's Disease. Journal of Gerontology: Psychological Sciences, 47(5), 337-343.
- Melton, A.W. (1967). Repetition and retrieval from memory. Science, 158, 532.
- Miller, E. (1975). Impaired recall and the memory disturbance in presenile dementia. British Journal of Social and Clinical Psychology, 14, 73-79.
- Miller, E. (1978). Retrieval from long-term memory in presenile dementia: Two tests of an hypothesis. British Journal of Social and Clinical Psychology, 17, 143-148.
- Mitchell, D.B., & Hunt, R.R. (1989). How much 'effort' should be devoted to memory? Memory and Cognition, 17, 337-348.

Mitchell, D.B., Hunt, R.R., & Schmitt, F.A. (1986). The generation effect and reality monitoring: Evidence from dementia and normal aging. Journal of Gerontology, 41(1), 79-84.

Modigliani, V. (1978). Effects of initial testing on later retention as a function of the initial retention interval. In M.M. Gruneberg, P.E. Morris, R.N. Sykes (Eds.), Practical aspects of memory (pp. 652-659). New York: Academic Press.

Moffat, N. (1984). Strategies of memory therapy. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of memory problems (pp. 63-87). Melbourne: Chapman & Hall.

Moffat, N. (1989). Home based cognitive rehabilitation with the elderly. In L.W. Poon, D.C. Rubin, & B.A. Wilson (Eds.), Everyday cognition in adulthood and late life (pp. 659-680). Cambridge: C.U.P.

Moffat, N. (1992). Strategies of memory therapy. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of Memory Problems (pp. 86-119). Melbourne: Chapman & Hall.

Money, E.A., Kirk, R.C., & McNaughton, N. (1992). Alzheimer's dementia produces a loss of discrimination but no increase of memory decay in delayed matching to sample. Neuropsychologia, 30, 133-143.

Morris, M.B., & Kopelman, M.D. (1986). The memory deficits in Alzheimer-type dementia: A review. The Quarterly Journal of Experimental Psychology, 28A, 575-602.

- Morris, R., Wheatley, J., & Britton, P. (1983). Retrieval from long-term memory in senile dementia: Cued recall revisited. British Journal of Clinical Psychology, 22, 141-142.
- Moss, M.B., Albert, M.S., Butters, N., & Payne, M. (1986). Differential patterns of memory loss among patients with Alzheimer's disease, Huntingdon's disease, and alcoholic Korsakoff's syndrome. Archives of Neurology, 43, 239-246.
- Murdoch, B.E., Chenery, H.J., Wilks, V., & Boyle, R.S. (1987). Language disorders in dementia of the Alzheimer's type. Brain and Language, 31, 122-137.
- Nelson, H.E., & McKenna, P. (1975). The use of current reading ability in the assessment of dementia. British Journal of Social and Clinical Psychology, 14, 259-267.
- Nordberg, A. (1992). Biological markers and the cholinergic hypothesis in Alzheimer's Disease. Acta Neurologica Scandinavica, 85(139), 54-58.
- Payne, D.G., & Wenger, M.J. (1992). Improving memory through practice. In D.J. Herrmann, H. Weingartner, A. Searleman, & C. McEvoy (Eds.), Memory improvement: Implications for memory theory (pp. 187-209). New York: Springer-Verlag.
- Perfect, T.J., Downes, J.J., DeMornay Davies, P., Wilson, K. (1992). Preserved implicit memory for lexical information in Alzheimers Disease. Perceptual and Motor Skills, 74, 747-754.
- Perruchet, P. (1989). The effect of spaced practice on explicit and implicit memory. British Journal of Psychology, 80, 113-130.

- Peterson, L.R. (1966). Short-term verbal memory and learning. Psychological Review, 73, 193-207.
- Pfeffer, R.I., Kurosaki, T.T., Harrah, C.H., Chance, J.M., Bates, D., Detels, R., Filos, S., & Butzke, C. (1981). A survey diagnostic tool for senile dementia. American Journal of Epidemiology, 114, 515-527.
- Plude, D.J. (1992). Attention and memory improvement. In D.J. Herrmann, H. Weingartner, A. Searleman & C. McEvoy (Eds.), Memory Improvement: Implications for Memory Theory (pp. 150-168). New York: Springer-Verlag.
- Pressley, M., & Beard El-Dinary, P. (1992). Memory strategy instruction that promotes good information processing. In D.J. Herrmann, H. Weingartner, A. Searleman & C. McEvoy (Eds.), Memory Improvement: Implications for Memory Theory (pp. 79-100). New York: Springer-Verlag.
- Rabinowitz, J.C., & Craik, F.I.M. (1986). Prior retrieval effects in young and old adults. Journal of Gerontology, 41(3), 368-375.
- Rabins, P.V., Mace, N.L., & Lucas, M.J. (1982). The impact of dementia on the family. Journal of the American Medical Association, 248, 333-335.
- Rea, C.P., & Modigliani, V. (1988). Educational implications of the spacing effect. In M.M. Gruneberg, P.E. Morris, & R.N. Sykes (Eds.), Practical aspects of memory: Current research and issues: Vol 1. Memory in everyday life (pp. 402-406). Chichester: Wiley.

- Reder, L.M., & Anderson, J.R. (1982). Effects of spacing and embellishment on memory for the main points of a text. Memory and Cognition, 10, 97-102.
- Reid, W.G.J. (1994). Neuropsychological assessment of dementia. In S. Touyz, D. Byrne, & A. Gilandas (Eds.), Neuropsychology in clinical practice (pp. 248-267). Sydney: Academic Press Inc.
- Riley, K.P. (1992). Bridging the gap between researchers and clinicians: Methodological perspectives and choices. In R.L. West & J.D. Sinnott (Eds.), Everyday Memory and Aging: Current Research and Methodology (pp. 182-189). New York: Springer-Verlag.
- Roman, G.C., Tatemichi, T.K., Erkinjuntti, T., Cummings, J.L., Masdeu, J.C., Garcia, J.H., Amaducci, L., Orgogozo, J-M., Brun, A., Hofman, A., Moody, D.M., O'Brien, M.D., Yamaguchi, T., Grafman, J., Drayer, B.P., Bennett, D.A., Fisher, M., Ogata, J., Kokmen, E., Bermejo, F., Wolf, P.A., Gorelick, P.B., Bick, K.L., Pajean, A.K., Bell, M.A., DeCarli, C., Culebras, A., Korczyn, A.D., Boyousslavsky, J., Hartmann, A., & Scheinberg, P. (1993). Vascular dementia: Diagnostic criteria for research studies. Report of the NINCDS-AIREN international workshop. Neurology, 43, 250-260.
- Rosner, S.R. (1970). The effects of presentation and recall trials on organisation in multitrial free recall. Journal of Verbal Learning and Verbal Behaviour, 9, 69-74.
- Ross, B.H., & Landauer, T.K. (1978). Memory for at least one of two items: Test and failure of several theories of spacing effects. Journal of Verbal Learning and Verbal Behaviour, 17, 669-680.

Russo, R., & Spinnler, H. (1994). Implicit verbal memory in Alzheimers Disease. Cortex, 30, 359-375.

Saltz, E. (1988). The role of motoric enactment (M-processing) in memory for words and sentences. In M.M. Gruneberg, P.E. Morris, & R.N. Sykes (Eds.), Practical aspects of memory: Current research and issues: Vol. 1. Memory in everyday life (pp. 408-414). Chichester: Wiley.

Schacter, D.L., Rich, S.A., & Stamp, M.S. (1985). Remediation of memory disorders: Experimental evaluation of the spaced-retrieval technique. Journal of Clinical and Experimental Neuropsychology, 7, 79-96.

Schneck, M.K., Reisberg, B., & Ferris, S.H. (1982). An overview of current concepts of Alzheimer's Disease. American Journal of Psychiatry, 139, 165-173.

Schneider, W. & Shiffrin, R.M. (1977). Controlled and automatic human processing: I. Detection, search, and attention. Psychological Review, 84, 1-66.

Senate Report (20th September, 1994). Canberra: Australian Government.

Shimamura, A.P., Salmon, D.P., Squire, L.R., & Butters, N. (1987). Memory dysfunction and word priming in dementia and amnesia. Behavioural Neuroscience, 101(3), 347-351.

Slamecka, N.J., & McElree, B. (1983). Normal forgetting of verbal lists as a function of their degree of learning. Journal of Experimental Psychology: Learning, Memory & Cognition, 9, 384-397.

Smith, C.U.M. (1989). Elements of molecular neurobiology. Brisbane: John Wiley & Sons.

Spreen, J., & Strauss, M. (1991). A compendium of neuropsychological tests: Administration, norms and commentary. New York: Oxford University Press.

Stevens, A.B., Camp, C.J., & O'Hanlon, A.M. (1992). Strategy training for individuals with Alzheimer's disease: The spaced-retrieval method. Poster presented at the Cognitive Aging Conference, Atlanta GA.

St George-Hyslop, P.H., Haines, J.L., Farrer, L.A., Polinsky, R., Van Broeckhoven, C., Goate, A., Crapper-McLachlan, D.R., Orr, H., Bruni, A.CC., Sorbi, S., Rainero, I., Foncin, J.F., Pollen, D., Cantu, J.M., Tupler, R., Voskresenskaya, N., Mayeux, R., Growdon, J., Fried, V.A., Myers, R.H., Nee, L., Backhovens, H., Martin, J-J, Rossor, M., Owen, M.J., Mullan, M., Percy, M.E., Karlinsky, H., Rich, S., Heston, L., Montesi, M., Mortilla, M., Nacmias, N., Gusella, J.F., & Hardy, J.A. (1990). Genetic linkage studies suggest that Alzheimer's disease is not a single homogeneous disorder. Nature, 347, 194-197.

St George-Hyslop, P.H., Tanzi, R.E., Polinsky, R.J., Haines, J.L., Nee, L., Watkins, P.C., Myers, R.H., Feldman, R.G., Pollen, D., Drachmen, D., Growdon, J., Bruni, A., Foncin, J-F., Salmon, D., Frommelt, P., Amaducci, L., Sorbi, S., Piacentini, S., Stewart, G.D., Hobbs, W.J., Conneally, P.M., & Gusella, J.F. (1987). The genetic defect causing familial Alzheimer's disease maps on chromosome 21. Science, 235, 885-890.

- Storandt, M., & Hill, R.D. (1989). Very mild dementia of the Alzheimer type; II. Psychometric Test performance. Archives of Neurology, 46, 383-386
- Terry, R.D., & Katzman, R. (1983). Senile dementia of the Alzheimer type. Annals of Neurology, 14, 497-506.
- Thompson, C.P., Wenger, S.K., & Bartling, C.A. (1978). How recall facilitates subsequent recall: A reappraisal. Journal of Experimental Psychology: Human Learning and Memory, 4(3), 210-221.
- Thomson, D.M., & Tulving, E. (1970). Associative encoding and retrieval: Weak and strong cues. Journal of Experimental Psychology: General, 86(2), 255-262.
- Tulving, E. (1966). Subjective organisation and effects of repetition in multi-trial free-recall learning. Journal of Verbal Learning and Verbal Behaviour, 5, 193-197.
- Tulving, E. (1983). Elements of episodic memory. Oxford: Clarendon Press.
- Tulving, E., & Thomson, D.M. (1973). Encoding specificity and retrieval processes in episodic memory. Psychological Review, 80, 352-357.
- Tuokko, H., & Crockett, D. (1989). Cued recall and memory disorders in dementia. Journal of Clinical and Experimental Neuropsychology, 11(2), 278-294.
- Tuokko, H., Hadjistavropoulos, T., Miller, J.A., & Beattie, B.L. (1992). The clock test: A sensitive measure to differentiate normal elderly from those with Alzheimer's Disease. Journal of the American Geriatrics Society, 40, 579-584.

- Tuokko, H., Vernon-Wilkinson, R., Weir, J., & Beattie, B.L. (1991). Cued recall and early identification of dementia. Experimental Neuropsychology, 13(6), 871-879.
- Tyler, S.W., Hertel, P.T., McCallum, M.C., & Ellis, H.C. (1979). Cognitive effort and memory. Journal of Experimental Psychology: Human Learning and Memory, 5(6), 607-617.
- Tzeng, O.J.L. (1973). Stimulus meaningfulness, encoding variability, and the spacing effect. Journal of Experimental Psychology: General, 99(2), 162-166.
- Ulrich, J. (1990). Recent progress in the characterisation of the pathological hallmarks for Alzheimer's Disease. Acta Neurologica Scandinavica, 82(suppl. 129), 5-7.
- Walsh, K.W. (1978). Neuropsychology: A clinical approach. New York: Churchill Livingstone.
- Wechsler, D. (1981). The Wechsler Adult Intelligence Scale - Revised. New York: Psychological Corporation.
- Wechsler, D. (1987). The Wechsler Memory Scale - Revised. New York: Psychological Corporation.

- Weingartner, H., Kaye, W., Smallberg, S., Cohen, R., Ebert, M.H., Gillin, J.C., & Gold, P. (1982). Determinants of memory failures in dementia. In S. Corkin, K.L. Davis, J.H. Crowdon, E. Usdin, & R.L. Wurtman (Eds.), Aging, Vol 19, Alzheimer's Disease: A Report of Progress (pp. 171-176). New York: Raven.
- Weingartner, H., Kaye, W., Smallberg, S.A., Ebert, M.H., Gillin, J.C., & Sitaram, N. (1981). Memory failure in progressive idiopathic dementia. Journal of Abnormal Psychology, 90, 187-196.
- Wenger, S.K., Thompson, C.P., & Bartling, C.A. (1980). Recall facilitates subsequent recognition. Journal of Experimental Psychology: Human Learning and Memory, 6(2), 135-144.
- West, R.L. (1989). Planning practical memory training for the aged. In L.W. Poon, D.C. Rubin, & B.A. Wilson (Eds.), Everyday cognition in adulthood and late life (pp. 573-597). New York: Cambridge University Press.
- Whitehouse, P.J., Price, D.L., Struble, R.G., Clark, A.W., Coyle, J.T., & DeLong, M.R. (1982). Alzheimer's disease and senile dementia: Loss of neurons in the basal forebrain. Science, 215, 1237-1239.
- Whitten II, W.B., & Bjork, R.A. (1977). Learning from tests: Effects of spacing. Journal of Verbal Learning and Verbal Behaviour, 16, 465-478.
- Willshire, D., Kinsella, G., & Prior, M. (1991). Estimating WAIS-R IQ from the National Adult Reading Test: A cross-validation. Journal of Clinical and Experimental Neuropsychology, 13, 204-216.

- Wilson, B.A. (1982). Success and failure in memory training following a cerebral vascular accident. Cortex, 18, 581-594.
- Wilson, B.A. (1992a). Memory therapy in practice. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of Memory Problems (pp. 120-153). Melbourne: Chapman & Hall.
- Wilson, B.A. (1992b). Rehabilitation and memory disorders. In L.R. Squires & N. Butters (Eds.), Neuropsychology of Memory (2nd Edition) (pp. 315-321). New York: The Guilford Press.
- Wilson, B.A., Baddeley, A., Evans, J., & Shiel, A. (1994). Errorless learning in the rehabilitation of memory impaired people. Neuropsychological Rehabilitation, 4, 307-326.
- Wilson, B.A., & Poon, L.W. (1989). Introduction to part III: Approaches to practical applications. In L.W. Poon, D.C. Rubin, & B.A. Wilson (Eds.), Everyday cognition in adulthood and late life (pp. 499-506). New York: Cambridge University Press.
- Wilson, R.S., Kaszniak, A.W., & Fox, J.H. (1981). Remote memory in senile dementia. Cortex, 17, 41-48.
- Wolf-Klein, G.P., Silverstone, F.A., Levy, A., Brod, M., & Breur, J. (1989). Screening for Alzheimer's disease by clock drawing. Journal of the American Geriatric Society, 37, 730-735.

Wood, R.L. (1992). Disorders of attention: Their effect on behaviour, cognition and rehabilitation. In B.A. Wilson & N. Moffat (Eds.), Clinical Management of Memory Problems (pp. 216-242). London: Chapman & Hall.

Zacks, T., & Hasher, L. (1992). Memory in life, lab, and clinic: Implications for memory theory. In D.J. Herrmann, H. Weingartner, A. Searleman & C. McEvoy (Eds.), Memory improvement: Implications for memory theory (pp. 232-248). New York: Springer-Verlag.

Zec, R.F. (1993). Neuropsychological functioning in Alzheimer's Disease. In R.W. Parks, R.F. Zec & R.S. Wilson (Eds.), Neuropsychology of Alzheimer's Disease and other dementias (pp. 3-80). New York: Oxford University Press.

APPENDICES

APPENDIX I.

Table 1

Criteria for Clinical Diagnosis of Probable and Possible Alzheimer's Disease (from McKhann et al. 1984).

Probable	Possible
<p>Includes:-</p> <ul style="list-style-type: none"> - Dementia established by clinical examination and documented by the Mini-Mental Test, Blessed Dementia Scale or some similar examination, and confirmed by neuropsychological tests. - Deficits in two or more areas of cognition - Progressive worsening of memory and other cognitive functions - No disturbance in consciousness - Onset between ages 40 and 90, most often after age 65 - Absence of systemic disorders or other brain diseases that in and of themselves could account for the progressive deficits in memory and cognition <p>Supported by:-</p> <ul style="list-style-type: none"> - Progressive deterioration of specific cognitive functions such as language (aphasia), motor skills (apraxia), and perceptions (agnosia) - Impaired activities of daily living and altered patterns of behaviour - Family history of similar disorders, particularly if confirmed neuropathologically 	<ul style="list-style-type: none"> - May be made on the basis of the dementia syndrome, in the absence of other neurologic, psychiatric, or systemic disorders sufficient to cause dementia and in the presence of variations in the onset, in the presentation or in the clinical course. - May be made in the presence of a second systemic or brain disorder sufficient to produce dementia which is not considered to be the cause of the dementia - Should be used in research studies when a single, gradually progressive severe cognitive deficit is identified in the absence of other identifiable cause.

Table 1 continued.....

- Laboratory results of normal lumbar puncture as evaluated by standard techniques, normal pattern or nonspecific changes in EEG such as increased slow wave activity and evidence of cerebral atrophy on CT with progression documented by serial observation.

Table 2

The Composition of the Psychogeriatric Assessment Scales*

Scale	Subject Interview	Informant Interview
Stroke	This scale assesses 6 symptoms of cerebrovascular disease. It gives an indication of whether cognitive impairment might be due to vascular dementia or to Alzheimer's Disease	This scale is identical to the Stroke scale given to the subject. It gives an independent source of information on cerebrovascular disease
Depression	This scale assesses 12 symptoms of depression over the previous 2 weeks	NOT APPLICABLE
Cognitive Impairment	This scale consists of 9 questions to test the subject's memory and other cognitive functions	NOT APPLICABLE
Cognitive Decline	NOT APPLICABLE	This scale asks the informant 10 questions about changes in the subject's everyday cognitive functioning
Behaviour Change	NOT APPLICABLE	This scale has 15 questions which assess changes in personality and disturbances in behaviour which may occur in dementia

* Taken from the Psychogeriatric Assessment Scales Users Guide and Materials, Jorm & MacKinnon, 1994.

APPENDIX II.

Table 1

Neuropsychological Test Battery Scores For The Dementia Group.

Subj	mms	lm-1	lm-2	fuld	dsf	dsb	dst	bost	fas	sim	trail	cloc
1	17	1	1	1	5	4	9	15	5	2	294s	6
2	18	1	0	1	9	6	15	37	9	8	74s	6
3	12	1	0	0	6	4	10	15	2	9	312s	2
4	10	2	1	1	3	3	6	12	14	0	179s	4
5	12	1	0	0	5	4	9	28	24	0	255s	6
6	8	0	0	-*	3	-*	3	12	-*	0	-*	-*
7	18	2	0	0	9	6	15	-"	31	3	-"	-"
8	19	5	0	1	6	7	13	28	20	0	68s	10
9	19	4	0	2	5	4	9	30	17	6	295s	6
10	12	6	1	2	3	4	7	-"	2	0	-"	3
11	15	1	0	0	5	4	9	23	16	4	117s	4
12	14	0	0	2	6	4	10	23	17	5	81s	5
13	19	0	0	2	11	6	17	31	53	12	145s	8

subj = subject number, mms = mini-mental state exam, lm-1 = prose passage immediate recall, lm-2 = prose passage delayed recall, fuld = fuld object memory test, dsf = digit span forwards, dsb = digit span backwards, dst = total digit span, bost = boston naming test, fas = verbal fluency - controlled word association test, sim = similarities, trail = trail making test-A, cloc = draw a clock test.

* = refusal to complete

" = unable to complete due to poor vision

Table 2

Neuropsychological Test Battery Scores For The Control Group.

Subj	mms	lm-1	lm-2	fuld	dsf	dsb	dst	bost	fas	sim	trail	clock
1	25	-	-	-	8	4	12	-	28	11	23s	7
2	30	5	3	4	12	9	21	47	45	9	67s	10
3	27	13	6	8	5	5	10	51	28	11	56s	10
4	27	8	2	6	6	4	10	37	27	2	44s	7
5	28	11	9	7	6	4	10	47	13	5	55s	9
6	25	10	7	5	4	4	8	39	24	4	-	-
7	29	10	12	8	6	6	12	51	25	15	51s	10
8	30	11	8	8	5	6	11	54	21	19	18s	10
9	30	9	8	8	7	5	12	48	28	3	67s	10
10	26	5	3	2	9	4	13	26	24	5	69s	7
11	29	10	3	4	8	8	16	44	27	13	21s	9
12	26	10	6	4	6	8	14	54	49	18	56s	9
13	28	9	11	7	5	3	8	40	32	5	35s	7
14	27	15	10	5	6	6	12	-	30	20	-	10
15	29	12	7	6	8	6	14	51	35	14	27s	7
16	27	12	13	5	8	8	16	45	34	16	141s	6
17	30	8	14	5	9	11	20	55	48	24	25s	10
18	28	6	4	6	5	5	10	26	24	13	65s	6
19	27	8	3	4	5	6	11	46	19	12	71s	9
20	30	17	17	7	5	7	12	55	31	18	90s	10

subj = subject number, mms = mini-mental state exam, lm-1 = prose passage immediate recall, lm-2 = prose passage delayed recall, fuld = full object memory test, dsf = digit span forwards, dsb = digit span backwards, dst = total digit span, bost = boston naming test, fas = verbal fluency - controlled word association test, sim = similarities, trail = trail making test-A, clock = draw a clock test.

Table 3

Demographic Data, MENT* And Estimated Premorbid Intelligence#.

Dementia Group					Control Group				
Subj	Sex	Age	MENT	Pre-int	Subj	Sex	Age	MENT	Pre-int
1	f	90	8	105	1	f	88	0	93
2	f	81	12	110	2	m	96	0	118
3	f	76	11	99	3	f	91	0	117
4	f	86	20	100	4	f	79	0	99
5	f	79	17	106	5	f	78	1	95
6	f	89	12	-	6	f	89	3	99
7	f	94	8	-	7	f	87	0	116
8	f	77	5	100	8	f	76	0	109
9	f	84	9	106	9	m	88	0	110
10	m	63	18	-	10	m	98	0	101
11	f	87	5	111	11	f	93	0	106
12	m	87	10	102	12	m	82	0	116
13	f	86	8	117	13	f	88	0	103
					14	f	86	0	-
					15	m	83	0	108
					16	f	102	4	114
					17	m	75	1	124
					18	f	78	1	105
					19	f	83	0	102
					20	f	79	0	115

* MENT = Activities of Daily Living scale from the London Psychogeriatric Rating Scale

Pre-int = Pre-morbid Intelligence estimate calculated from error scores on the National Adult Reading Test.

Subj = Subject number

APPENDIX III.

Table 1

Correlation Matrix for Neuropsychological Test Battery, Level of Impairment (MMSE) and Activities of Daily Living Measure (MENT).

	11	12	ful	dsf	dsb	dst	bos	fas	sim	tra	clo	ment
mm	.189	-.278	.225	.709*	.750*	.814*	.739*	.447*	.463	-.248	.752*	-.676*
11		.337	.273	-.316	.113	-.073	.233	-.308	-.398	.012	.087	.126
12			.236	-.501	-.490	-.409	-.555	-.446	-.440	.291	-.320	.519
ful				.000	.000	.000	.302	.120	.185	-.224	.243	.086
dsf					.740*	.952*	.716*	.679*	.740*	-.361	.488	-.473
dsb						.880*	.679*	.479	.244	-.559	.778*	-.541
dst							.775*	.651*	.629*	-.464	.630*	-.481
bos								.452	.439	-.432	.579	-.279
fas									.353	-.280	.602*	-.289
sim										.000	.001	-.365
tra											-.413	.239
clo												-.477

mm = mini-mental state exam, 11 = prose passage immediate recall, 12 = prose passage delayed recall,

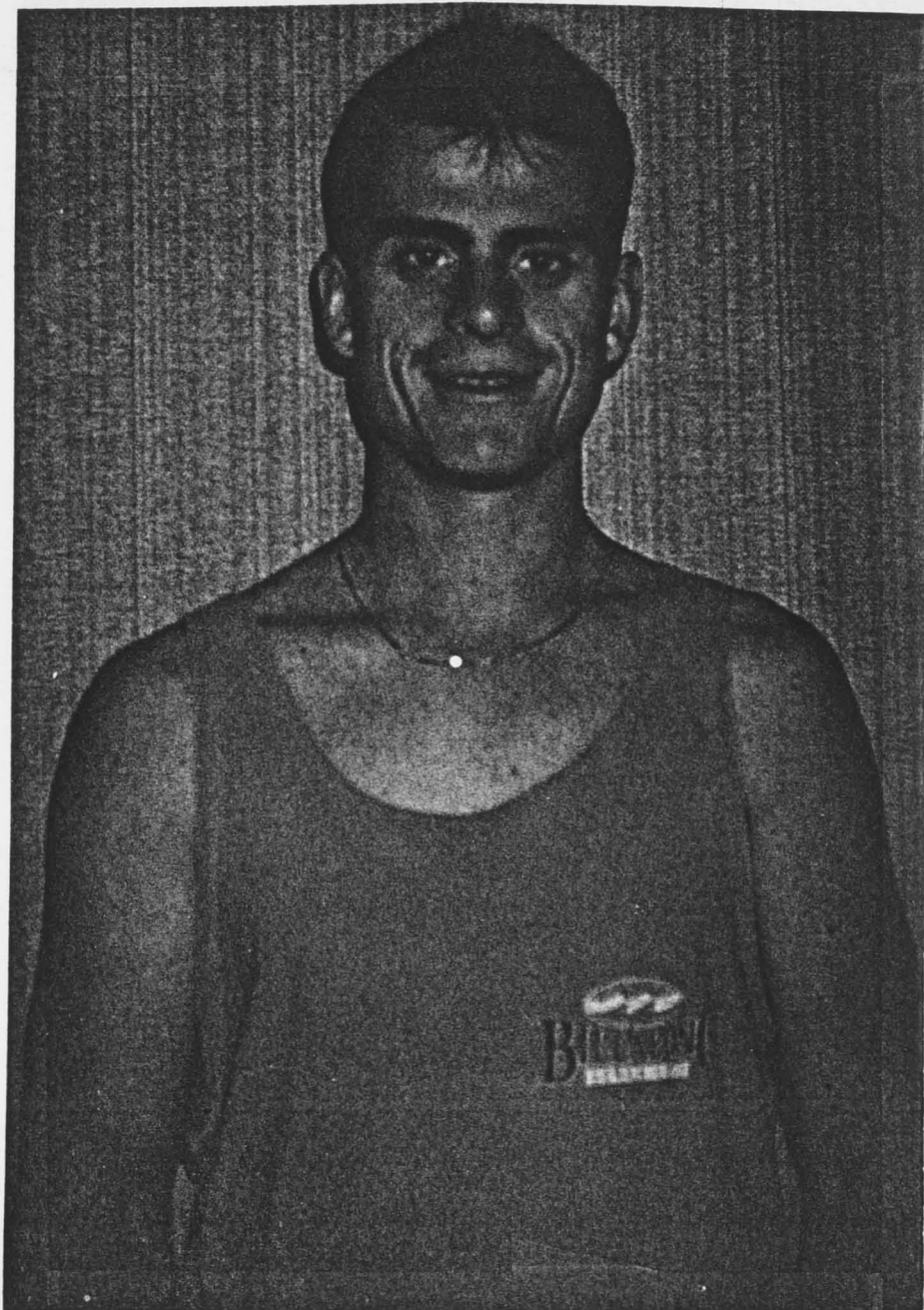
ful = full object memory test, dsf = digit span forwards, dsb = digit span backwards, dst = total digit span, bos = boston naming test, fas = verbal fluency - controlled word association test, sim = similarities,

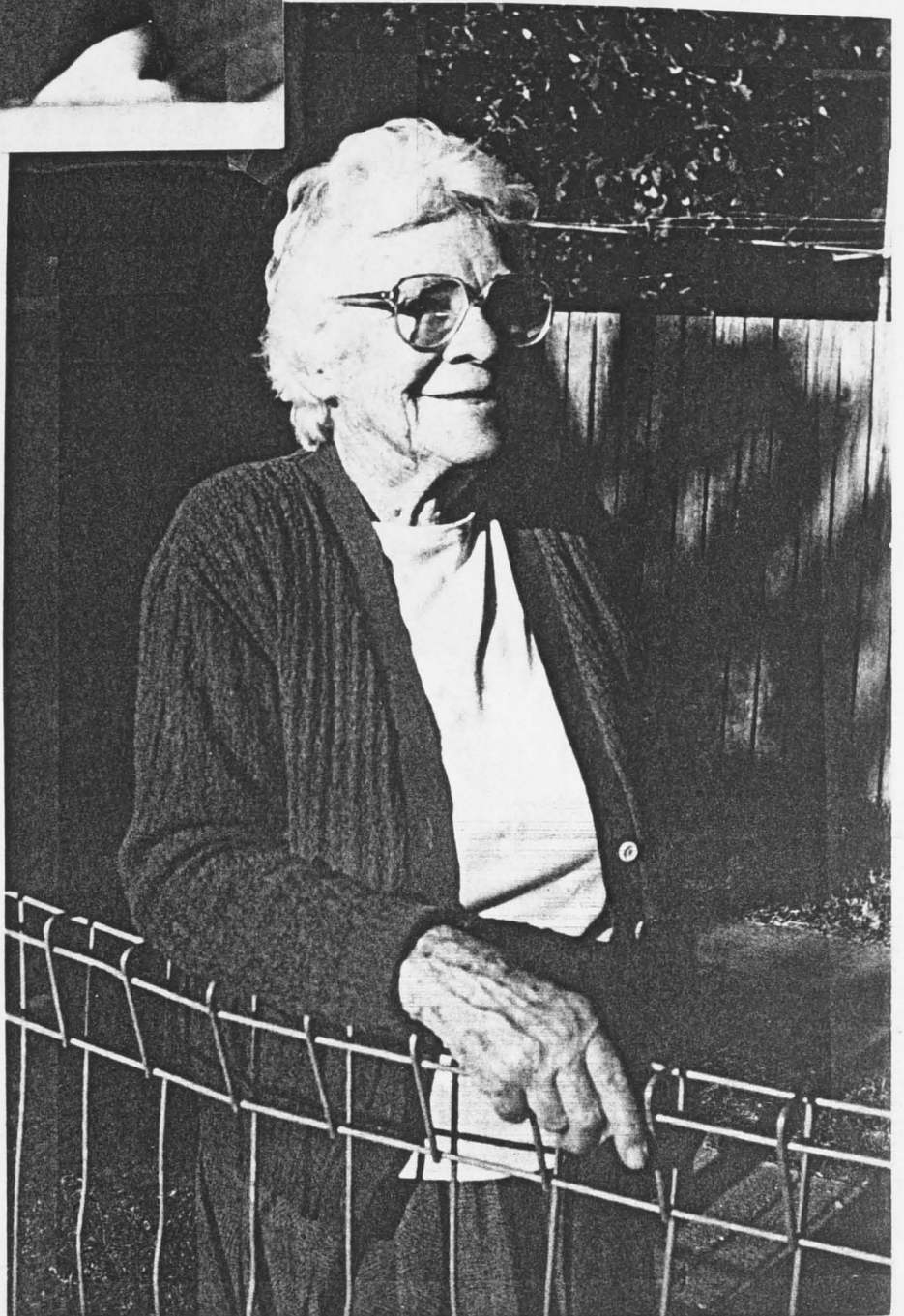
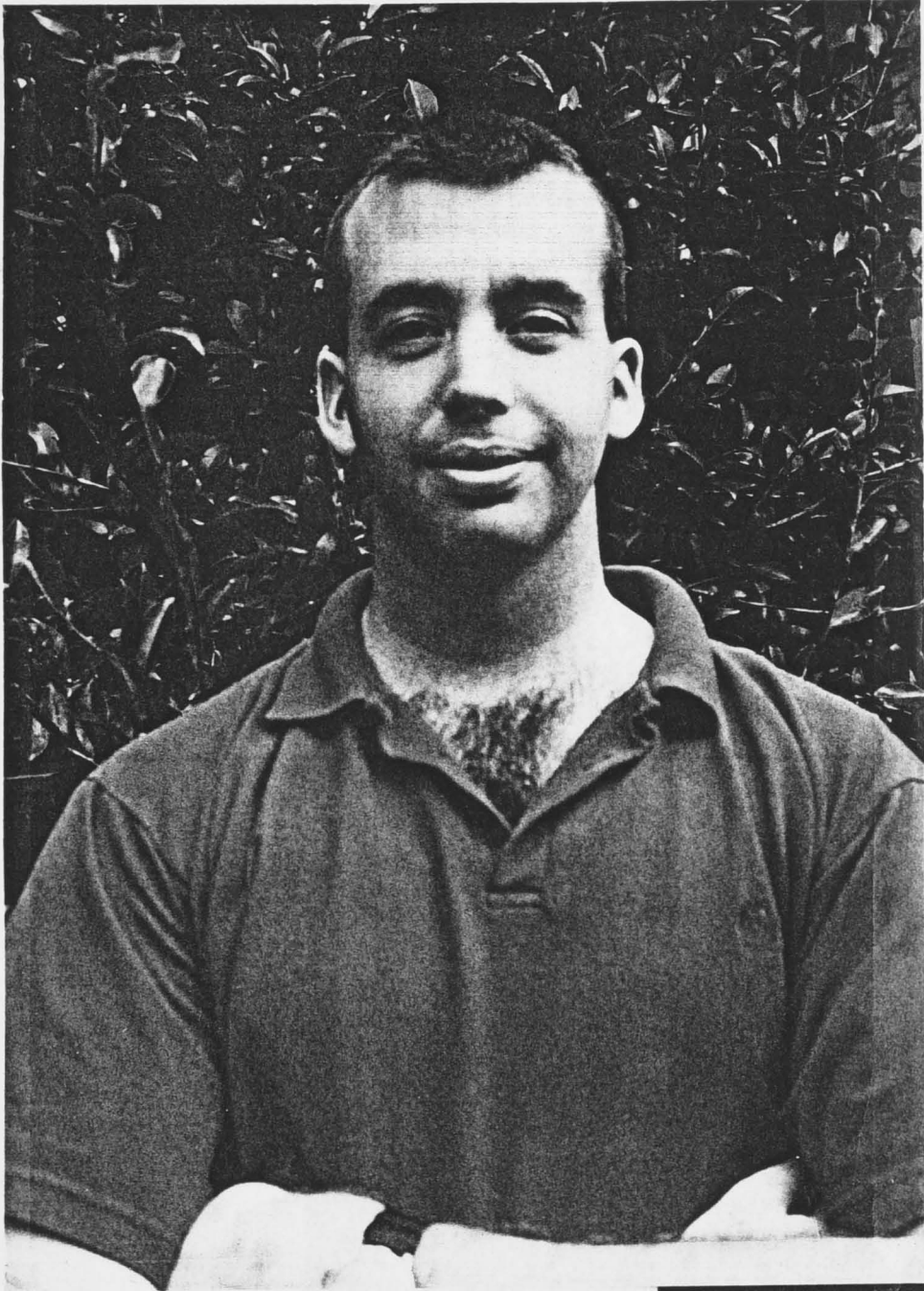
tra = trail making test-A, clo = draw a clock test, ment = Activities of Daily Living scale from the London Psychogeriatric Rating Scale.

* $p < 0.05$

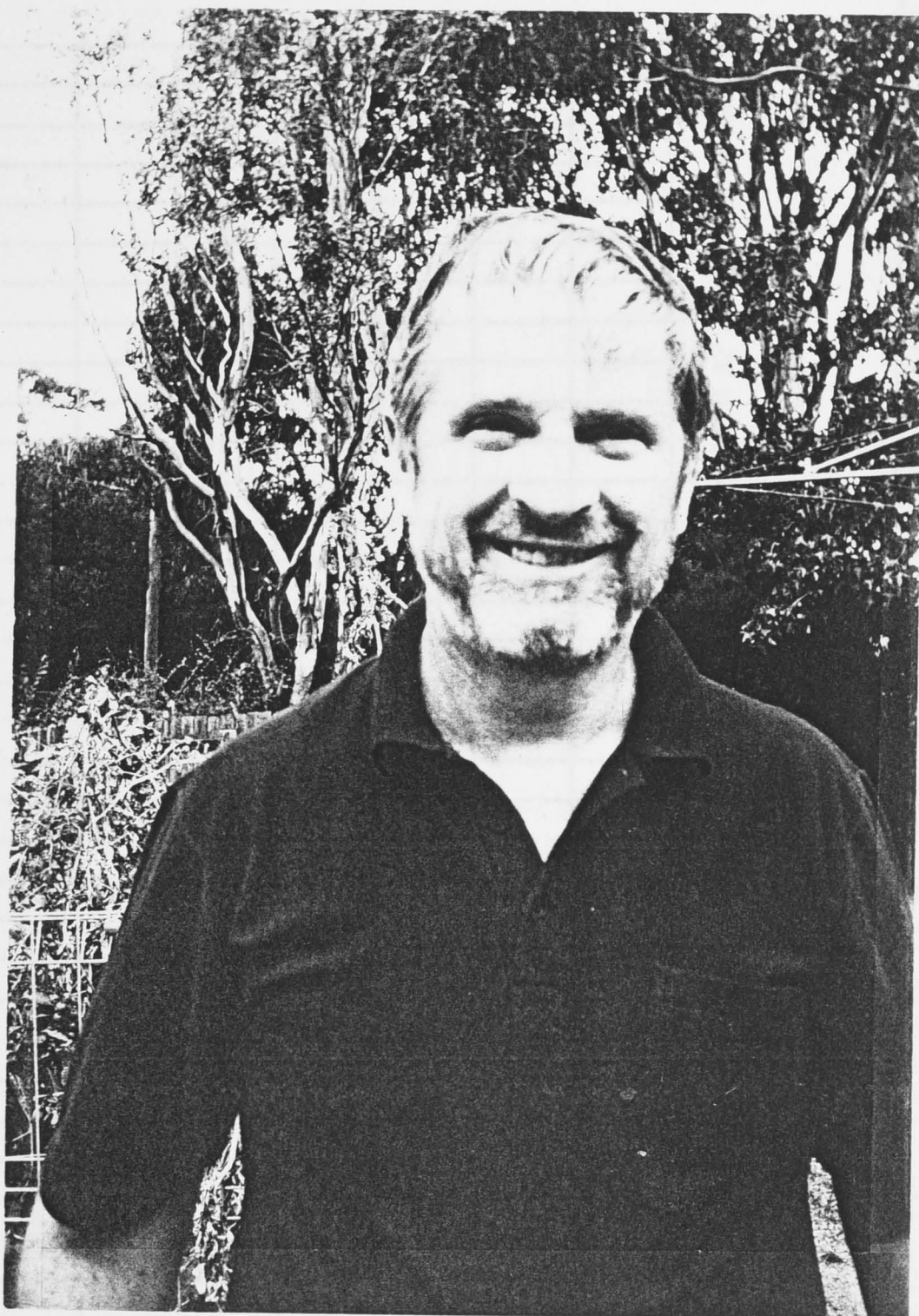
APPENDIX IV.

Photographs and names used in the experiment.





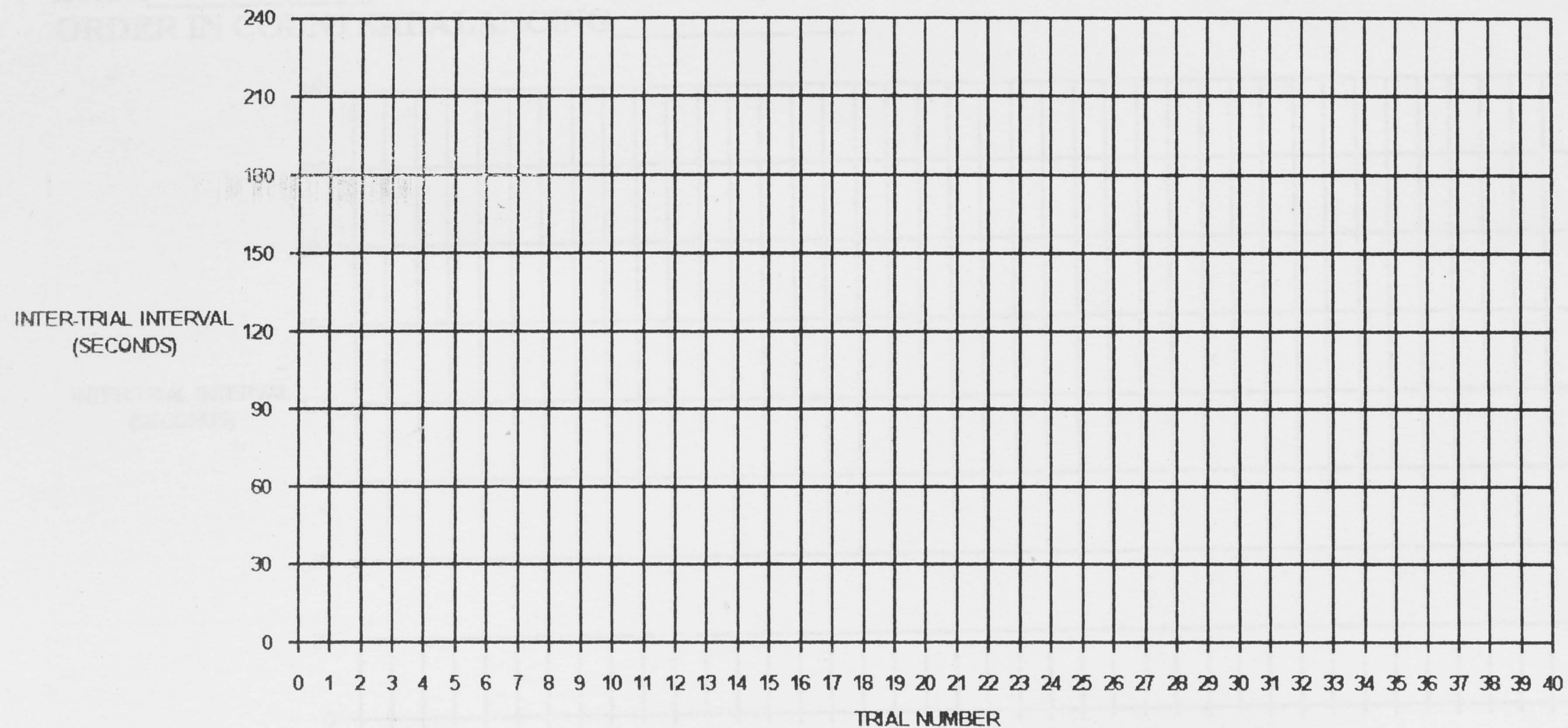
Mr / Mrs C. J. ...
 Mr / Mrs ...
 Mr / Mrs ...
 Mr / Mrs ...
 Mr / Mrs ...



Names used:

Mr / Mrs Crockett
Mr / Mrs Newcombe
Mr / Mrs Freeman
Mr / Mrs Maloney
Mr / Mrs Sturgess

SPACED RETRIEVAL TRIAL - PRE-TEST SUBJECT CODE _____
 DATE _____ TIME OF TESTING _____



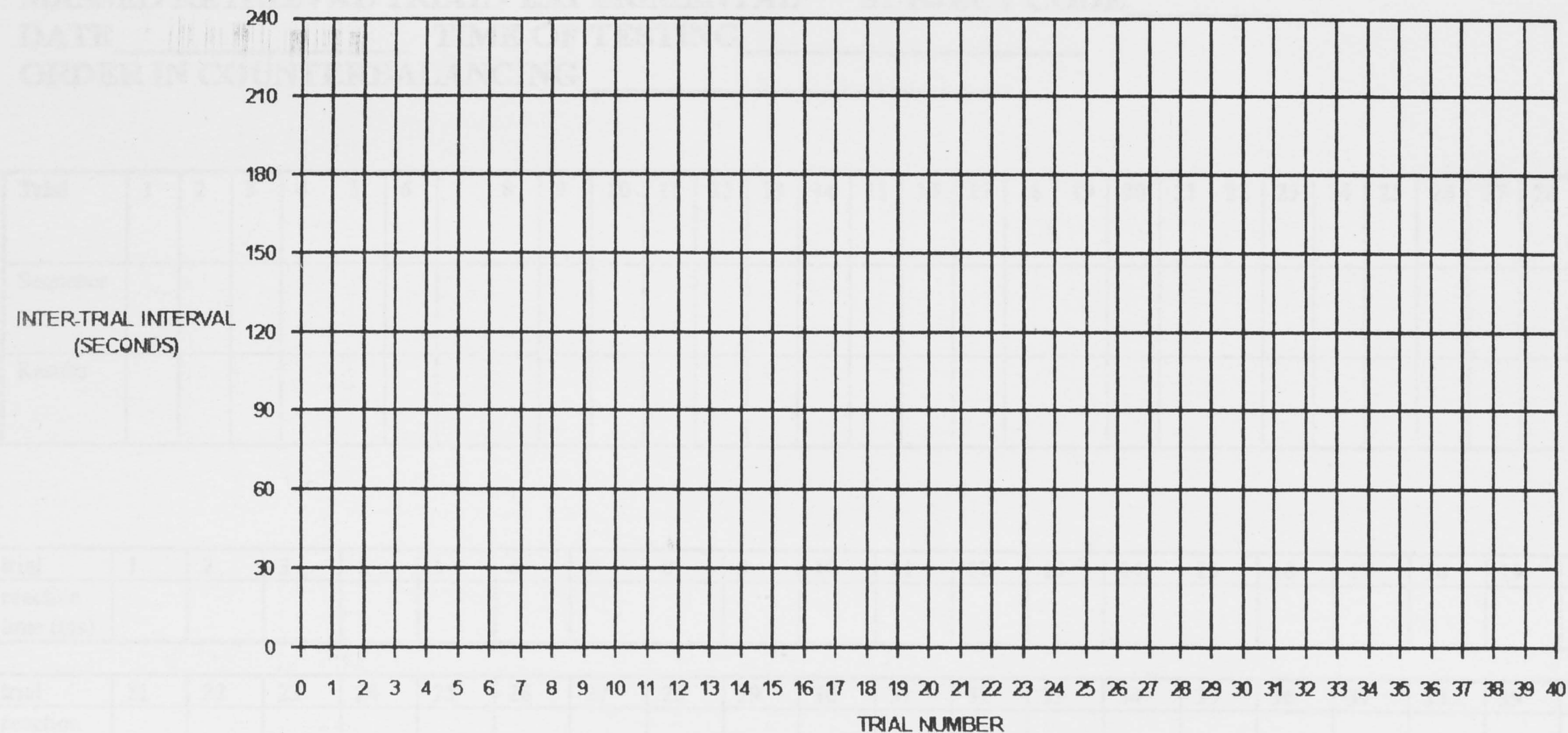
trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
reaction time (ms)																				

trial	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
reaction time (ms)																				

Record forms used during the experiment.

APPENDIX V.

SPACED RETRIEVAL TRIAL - EXPERIMENTAL SUBJECT CODE _____
 DATE _____ TIME OF TESTING _____
 ORDER IN COUNTERBALANCING _____



trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
reaction time (ms)																				

trial	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
reaction time (ms)																				

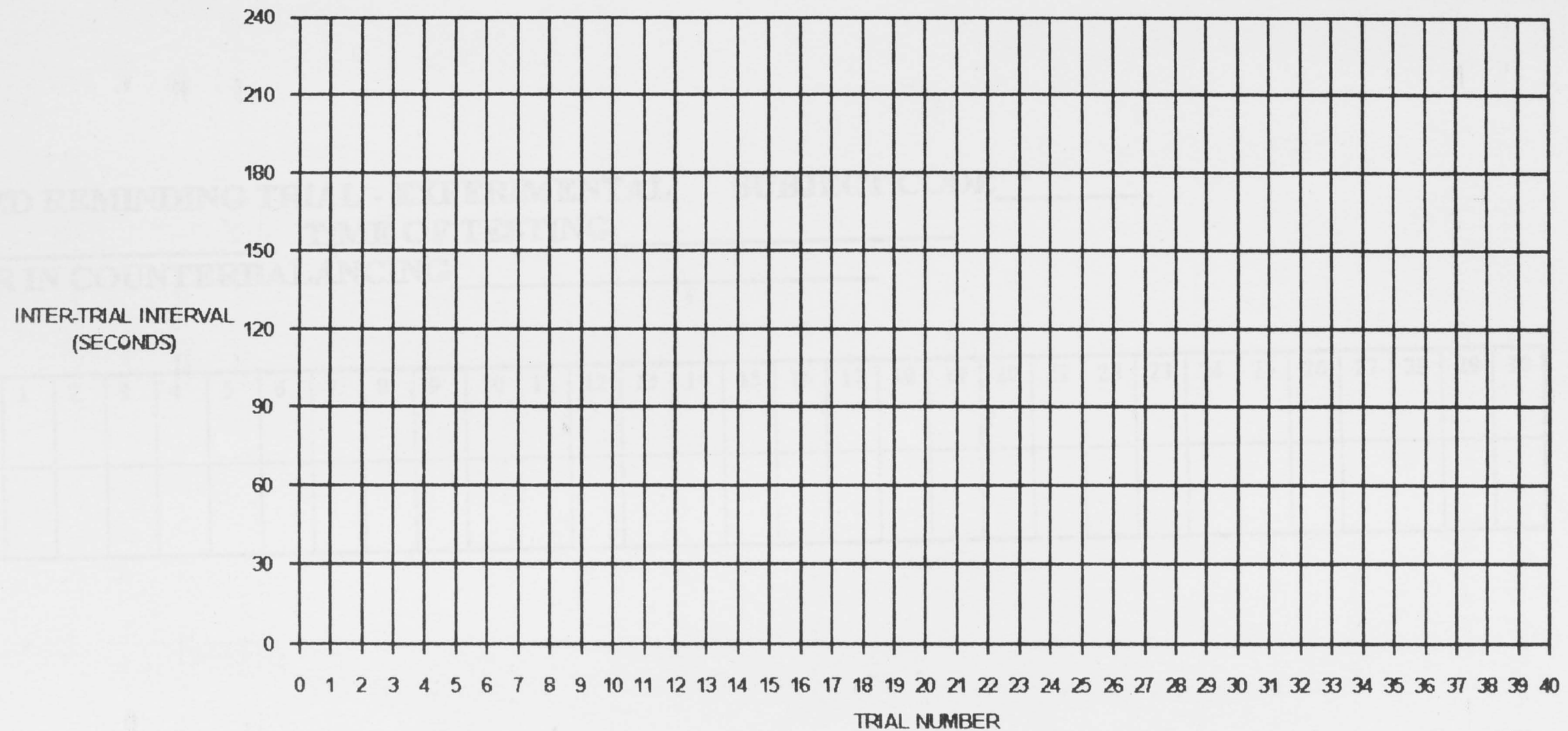
MASSED RETRIEVAL TRIAL - EXPERIMENTAL **SUBJECT CODE** _____
DATE _____ **TIME OF TESTING** _____
ORDER IN COUNTERBALANCING _____

Trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Sequence																														
Results																														

trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
reaction time (ms)																				

trial	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
reaction time (ms)																				

SPACED REMINDING TRIAL - EXPERIMENTAL SUBJECT CODE _____
DATE _____ TIME OF TESTING _____
ORDER IN COUNTERBALANCING _____



MASSED REMINDING TRIAL - EXPERIMENTAL **SUBJECT CODE** _____
DATE _____ **TIME OF TESTING** _____
ORDER IN COUNTERBALANCING _____

Trial	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Results																														

APPENDIX VI.

Table 1

Number of Cues Needed (Letters in the Surname) To Retrieve the Face-Name
Association After a One Hour Delay in the Pre-Test and Four Experimental
Conditions.

Subject	Pre-test Spaced Retrieval	Spaced Retrieval	Spaced Reminding	Massed Retrieval	Massed Reminding	Maximum Short-term Memory Span (seconds)
1	1	4	5	6	6	30
2	4	4	7	6	4	10
3	2	3	6	7	7	10
4	4	6	7	4	6	10
5	2	4	7	0	7	20
6	7	4	3	5	7	10
7	2	0	7	4	4	25
8	4	4	7	5	6	25
9	4	5	3	7	6	30
10	0	2	4	5	2	30
11	0	3	7	8	7	20
12	0	1	7	4	7	15
13	2	4	3	5	2	30

Table 2

Number of Training Trials Required to Reach 240 Second Retention Interval at
Performance Following Training (Cues Required to Retrieve the Association) in Both
Pre-Test and Experimental Spaced Retrieval Encoding Conditions.

Subject	Number of Trials in Training		Cues Required at Delay	
	Pre-test	Experimental	Pre-test	Experimental
1	14	11	1	4
2	11	14	4	4
3	11	11	2	3
4	11	19	4	6
5	35	14	2	4
6	18	14	7	4
7	11	14	2	0
8	14	17	4	4
9	11	11	4	5
10	11	11	0	2
11	24	19	0	3
12	14	11	0	1
13	11	14	2	4

APPENDIX VII.

Table 1

Analysis of Variance Summary Table for Photo/Name Order Effects.

Source	df	Sums of Squares	Mean Square	F-Value	P-Value
Order	4	3.31	0.83	0.18	0.944
Error	8	37.50	4.69		
Encoding Condition	3	30.00	10.00	3.19	0.042*
Order * Encoding Condition	12	40.33	3.36	1.07	0.422
Error	24	75.17	3.13		

*p < 0.05

Table 2

Analysis of Variance Summary Table for Encoding Condition Order Effects.

Source	df	Sums of Squares	Mean Square	F-Value	P-Value
Order	3	5.62	1.87	0.48	0.705
Error	9	35.19	3.91		
Encoding Condition	3	40.40	13.47	3.61	0.026*
Order * Encoding Condition	9	14.77	1.64	0.44	0.901
Error	27	100.73	3.73		

*p < 0.05

Table 3

Analysis of Variance Summary Table for Effect of Diagnosis.

Source	df	Sums of Squares	Mean Square	F-Value	P-Value
Diagnosis	1	0.04	0.04	0.01	0.920
Error	11	40.77	3.71		
Encoding Condition	3	37.00	12.33	3.78	0.020*
Diagnosis by Encoding Condition	3	7.84	2.61	0.80	0.502
Error	33	107.66	3.26		

*p < 0.05

APPENDIX VIII.

Table 1

One-Way Repeated Measures Analysis of Variance Summary Table for Encoding Condition Effects (Four).

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Constant	1	1240.69	1240.69	364.84	0.000*
Error	12	40.81	3.40		
Encoding Condition	3	41.00	13.67	4.26	0.011*
Error	36	115.50	3.21		

*p < 0.05

Table 2

Post Hoc Analysis of the Four Encoding Conditions (Newman Keuls).

	spaced reminding	massed reminding	massed retrieval	spaced retrieval
spaced reminding	-	0.153	0.538	2.23*
massed reminding		-	0.385	2.077*
massed retrieval			-	1.692*
spaced retrieval				-

* p < 0.05

Table 3

Analysis of Variance Summary Table for Encoding Condition Effects (Three).

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Constant	1	1130.77	1130.77	313.88	0.000*
Error	12	43.23	3.60		
Encoding Condition	2	2.00	1.00	0.29	0.749
Error	24	82.00	3.42		

*p < 0.05

Table 4

Analysis of Variance Summary Table for Effect of Level of Impairment.

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Impairment	1	0.39	0.39	0.10	0.752
Error	11	40.42	3.67		
Impairment by Encoding Condition	3	12.14	4.05	1.29	0.294
Encoding Condition	3	41.29	13.76	4.39	0.010*
Error	33	103.36	3.13		

*p < 0.05

APPENDIX IX.

Table 1

Response Time (Seconds) of Dementia Subjects to Retrieve the Face-NameAssociation on Each Subject's Initial Trial, Middle Trial and Final Trial of the SpacedRetrieval and Massed Retrieval Training Sessions.

subject	srt-initial	srt-middle	srt-final	mrt-initial	mrt-middle	mrt-final
1	1.00	1.32	0.82	1.08	1.12	1.18
2	1.13	2.24	1.78	1.31	1.05	0.92
3	0.73	1.09	2.20	1.04	1.00	0.99
4	0.94	1.27	1.59	0.71	0.87	1.37
5	0.65	1.61	1.52	0.96	0.63	1.09
6	1.82	2.10	8.07	1.20	0.92	0.54
7	0.76	1.78	2.31	1.56	1.28	1.41
8	0.66	0.82	0.54	0.60	0.83	0.97
9	0.58	1.35	1.65	1.13	0.57	0.61
10	0.46	0.78	0.77	0.77	0.67	0.59
11	1.34	1.17	1.13	0.65	0.83	0.52
12	1.19	10.23	13.09	1.25	0.55	0.61
13	0.57	0.57	7.81	0.43	0.60	0.94

srt = spaced retrieval encoding training session, mrt = massed retrieval encoding training session.

Table 2

Two-way Analysis of Variance Summary Table for Response times in the TwoRetrieval Encoding Conditions.

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Constant	1	174.87	174.87	28.29	0.000*
Error	12	74.18	6.18		
Retrieval Encoding Condition	1	27.23	27.23	4.15	0.064
Error	12	78.67	6.56		
Training Session Stage	2	18.05	9.03	4.49	0.022*
Error	24	48.25	2.01		
Training Session Stage by Retrieval Encoding Condition	2	20.19	10.09	4.27	0.026*
Error	24	56.69	2.36		

*p < 0.05

Table 3

One-way Analysis of Variance Summary Table for Response Time to Respond at the Three Stages of the Spaced Retrieval Training Condition.

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Constant	1	170.06	170.06	13.50	0.003*
Error	12	151.13	12.59		
Training Session	2	38.12	19.06	4.42	0.023*
Stage Error	24	103.60	4.32		

*p < 0.05

Table 4

One-way Analysis of Variance Summary Table for Response time to Respond at the Three Stages of the Massed Retrieval Training Condition.

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Constant	1	32.04	32.04	223.20	0.000*
Error	12	1.72	0.14		
Training Session	2	0.12	0.06	1.08	0.355
Stage Error	24	1.34	0.06		

*p < 0.05

APPENDIX X.

Table 1
Correlation Matrix: Relationship of Neuropsychological Test Battery to One Hour
Delayed Recall of the Face-Name Association (Number of Cues Required for Correct
Recall) in Each of the Four Experimental Conditions in the Dementia Group.

	mm	lm-1	lm-2	fuld	dsf	dsb	dst	bost	fas	sim	trails	clock
srt	-.099	.020	.218	.128	-.277	.206	-.273	-.064	-.046	-.050	.294	.288
srm	.015	-.092	-.092	-.65*	.081	.060	.214	.061	-.207	-.202	-.445	-.070
mrt	.280	.090	-.022	.103	.037	.012	.031	-.056	-.309	.421	.017	-.206
mrmm	-.369	-.324	-.245	-.455	-.473	-.420	-.502	-.549	-.345	-.286	.278	-.145

srt = spaced retrieval encoding condition, srm = spaced reminding encoding condition, mrt = massed retrieval encoding condition, mrmm = massed reminding encoding condition, mm = mini-mental state exam, lm-1 = prose passage immediate recall, lm-2 = prose passage delayed recall, fuld = fuld object memory test, dsf = digit span forwards, dsb = digit span backwards, dst = total digit span, bost = boston naming test, fas = verbal fluency - controlled word association test, sim = similarities, trail = trail making test-A, clock = draw a clock test.
* p < 0.05.